THE GREAT DELUSION

A Study of Aircraft in Peace and War

By

NEON

WITH A PREFACE BY

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PREFACE

THIS morning, within a few days of finishing Neon, I found in *The Times* an account of the latest of the world's wonders. London editors had been chatting wirelessly over the ether with their opposite numbers in New York; and Sir Samuel Hoare had travelled safely by air to Karachi. This, coming on the top of the book I had just read, set me thinking of all the changes that steam, electricity, the internal combustion engine, and wireless had brought about in little more than a century. Fifty years ago, when I was a boy of ten, my father was fifty-seven years of age. Yet he and his brother at the end of their holidays had generally walked to Eton from my grandfather's house in Old Burlington Street. Then, as a freshman, and indeed for years after, when he went to Oxford from London or Wiltshire, he had mostly gone by coach. Railways, in short, came into existence in his time. Save, perhaps, for better roads—and springs to the carriages made for the better roads—locomotion, in his schooldays, was as it had been in the days of Alexander the Great. And for that matter, no military pursuit could then have improved on Pharaoh when he started to overtake the hastily emancipated Children of Israel. But all this notwithstanding, in 1877 there were plenty of express trains that did sixty miles an hour.

Again, the Transatlantic cable was still a novelty, more recent, in fact, than is wireless now. It was, I suppose, about of the same age as the heavier-than-air flying machine. But London knew all it needed to know of the daily happenings in Europe, America, and Asia, and heard everything that mattered in the way of changes in the world's financial and commercial

markets. In little more than half a century things certainly had changed amazingly, and it was a current saying that "steam and electric telegraph had annihilated both space and time." And so recent was it all, that the phrase hardly seemed an exaggeration.

Now, half a century later, men are actually hearing the voices of their friends—and others—talking to them through 3,000 miles of ether, for all the world as if they were in the next street; and the travelling time between London and India has been reduced, we are told, to four days and a half. In the presence of portents so strange, who will blame the correspondents if they rhapsodise a bit, and, with almost lyrical enthusiasm, echo what we were saying half a century ago? Here is a correspondent's message about the new telephony:

> "Yesterday we signalled; to-day we speak; to-morrow we shall see. What now shall separate us? Is the day too far off to foresee when airships and aeroplanes and radio shall make of the whole earth but one place and when, by the miracle of wireless telephony and television, the Commonwealth of nations shall take counsel together—Homeland and Dominions and Colonies—over a table as wide as the world, brought face to face in sound and sight over all the great oceans between?"

This is, of course, excellent journalism—that is, excellent rhetoric. But is wireless telephony an advance on its wireful elder brother? And if wire-telephony over a submarine cable is forbidden to us, is telephony at this cost, and with broadcast publicity, a real advance on the electric cable? It sets one wondering about the other wonders that have come in my time—the pedal bicycle, the motor bicycle, the motor car, the lorry,

the dirigible, the aeroplane—do these, with to-day's last new things, create a new revolution in transport and communication comparable to what our elders saw? Are any of these truly steps in progress, as great, as valuable to mankind as were steam and the electric telegraph? We must, I think, put the work of Otto Daimler and those who completed the perfection of the petrol engine, on one side as an achievement of undoubted and vast utility. However we look at it, it measures up bravely against any other material advance in human progress. But what of aircraft? What of to-day's wireless telephoning? Another quotation from this morning's paper may help us to an answer. The telephonic experiment for a time worked splendidly. At first, indeed, it seemed to work too well, for some of those who had booked dates had to be prematurely hurried to their task, so swiftly did the loquacity—or the pockets—of their predecessors become exhausted. But before the first rush of orders had been met, a change came over the scene:

> "The Post Office announced last night that, although the Transatlantic telephone service opened satisfactorily, radio reception deteriorated after sunset on account of bad atmospheric conditions. As a result it was found impossible to complete all the calls which had been booked. Conditions as regarded atmospherics were exceptionally bad."

The truthful *Times* is ruthless. The ether, to use the tag of the day, had momentarily been conquered, and had then turned round to bite its conquerors. There seems, then, to be all the world of difference between the cable and the ether. The first is an unchanging medium; keep it supplied with current, and it will do its work by day or night, in rain or shine. But the ether is

literally a fair-weather servant. A miracle, no doubt, when in the mood; but if it takes offence—and its temper is fickle—it is worse than a dumb dog. It is a barking, shrieking pack of curs. And the worst of it is that you cannot forecast when the mood will be right, nor when the right mood will change to the wrong.

And so, with Neon still in my head, and the questions I have just posed before me, it seemed to me that quite possibly here we might have a clue to the relative values of the first advances and the last. Telephonic wireless does undoubtedly enable us to talk to New York and hear New York's replies. We cannot now, perhaps we never shall, converse by any other means. Similarly dirigibles and planes, with the air for their highway, have at times a speed and a freedom that no other vehicle can command. Clearly there may be moments when such freedom and speed may be beyond price. But what is the general utility of a vehicle that may not be at your command at the moment you want it most—at the strategic moment, that is to say? What of a method of conversing that fails you at perhaps the only time when you really want to converse?

It helps one to place these things in a truer light if one imagines the sequence of inventions to have been reversed. Let us suppose that all that the internal combustion engine has done for cars, airships, and aircraft, and all that wireless has done in the way of signalling, broadcasting, and the new telephony, had preceded, instead of following, the changes made by steam and electricity. Let us imagine that railways and steamships had come into being, in all their present completeness, early in this century, instead of in the second quarter of the last. Would the revolution they would have effected in our time have been sensibly less than it

actually was, coming when it did? Let us suppose it a novelty that the passage of the Atlantic by large, luxurious, and unsubsidised ships, starting at fixed times, and travelling at regular and high speeds, could be looked upon, in point of safety, as the virtual certainty we know it to be. Think of the volume of freight and passenger traffic carried to-day on the seas to all parts of the world, as a wholly new thing. What should we say of the astounding saving in cost or the incalculable gain in time and punctuality? Picture—again as a new thing—the network of rails that score the world, with trains crossing continents at 20 to 60 miles an hour, drawing incredible loads with incredible cheapness, starting and arriving with a certainty and a punctuality greater even than that of ships, and as great commercial undertakings. Imagine, again, in the place of long-distance wireless signalling and telephony, messages sent with the speed, the certainty, the secrecy, the volume and the cheapness which mark the overwhelming superiority of the unsubsidised electric wire over the ether!

Is not the difference between the two groups something like this? The advances of our day have truly enabled us to do things that can be done no other way. And, unquestionably, these are things that might occasionally be of very great value. The steamship, the steam engine, the motor car, and more particularly the electric telegraph, have, that is, left gaps. The aeroplane and the wireless have filled the gaps. The wonder of these things is so great that we are tempted to forget first that the gaps are narrow, next that they are only sometimes filled, and lastly, only filled at enormous cost. It would be great fun to have an Aladdin Lamp if the Djin came up smiling whenever the lamp was rubbed, and then did your bidding with the swift celerity of the fairy tale.

But if he came when the spirit, and not the lamp, moved him, and only did his job when the weather permitted; if when you asked for a magic carpet to Karachi, he might casually drop you into the Mediterranean with no other apology than it had been quite impossible to foresee that the meteorological conditions would be so bad; and finally, if he never did even the smallest job except in exchange for a cheque that left your bank account spavined for good and all—why, then, shares in "Magic Lamps Limited" might stand at a heavy discount.

Thus, the happenings of yesterday prepare us for the book it is my business to introduce to-day. If the publication of "The Great Delusion" is an event, it is simply because the truth about flying is at last told. And it is not a comforting truth. When Lasker analysed the Evans gambit, an attack that had intrigued the masters for two generations, he was said to have "taken the romance out of it." All he had done was: to devastate a fallacy by showing it for what it was. Neon in turn has stripped flying of its hocus pocus. The conjurer's tricks are all explained; the magician is unmasked; the children's party is a fiasco. The reader is uneasily conscious of being gradually but relentlessly ushered out of Eden. He may leave it finally with regret. But it was a Fool's Paradise into which he was inveigled.

The strange thing is that, despite the rudeness of the onslaught, no new discoveries seem to have been made. No hoard of secrets has been unearthed. The physical laws that govern flight have been set out. A long array of facts have been collected which tend to show that our expectations from aircraft never have and never will be realised. But they are neither new, nor

hitherto hidden, nor inaccessible facts. They have been amassed by diligent search from such universally available authorities as Hansard, the daily papers, and the scientific journals. Neon has, in fact, done little more than quote the laws and collect the facts that show these laws in operation. But so well have the relevant laws been marshalled, with a sufficiency of the facts, that the case does not rest on any argumentative ingenuity. The conclusions do not even have to be formulated. The laws and facts speak for themselves.

Well, the disinterested reader will be left somewhat painfully disillusioned. Flying, whether by dirigible or plane, is not really all that we have been made to believe. It was said of a famous London club that the incomes of all the crack bridge players dropped the best part of £5,000 a year when the *nouveaux riches* learnt the card values of their hands. Is it possible that the headstrong but slightly light-headed experts of the Air Ministry have been over-declaring?—and with the usual results to us, their partners? It is not impossible. And yet flying, though a mere youngster, has been educated, let us say cultivated, intensively and regardless of effort and financial cost. Throw your mind back to what the belligerents did to develop and perfect aeroplanes between 1914 and 1918. How much research, experiment, sheer cumulative experience in building and flying, did those five years of competing effort by the most highly equipped industrial nations mean? Surely there must have been spent in this way more on flying in four years than was spent in developing the use of steam on land and sea in the fifty years between 1825 and 1875. The bulk of it, of course, was spent on aeroplanes. That less was done with airships is not surprising when we consider the staggering disadvantages

inseparable from this strange craft. And yet, on airships alone, the total spent by this country, even since the war, is considerable. What have we got from it all? Where does flying stand to-day? This is just what "The Great Delusion" tells its readers.

The aeroplane and the airship share with the submarine the curious distinction of being vehicles that work in a single medium. All others work in two. It is this fundamental distinction which introduces insoluble navigational disabilities for long-distance airship flights, for reasons which the early chapters of this book make abundantly clear. Over and above the navigational dangers airship passengers will be exposed to the terrible risks of fire and lightning and exhaustion of fuel, whilst the risk of collapse of the absurdly flimsy structure is ever present. But discomfort is superimposed upon danger, as will readily be understood when we reflect that these giant airships, as large as the *Mauretania*, have only a theoretical disposable load of something under ten tons for passengers and their luggage and comforts. If things go against you in the air, tank after tank has to be jettisoned, for it is better to lose your power of propulsion and trust to the winds to take you somewhere where you may be able to land, than to be dumped in mid-ocean. This being so, while we recognise a certain justice in the proposal that the projected commercial airships should charge more for fat people than for thin, it is comforting to reflect that the passengers themselves—unlike their baggage, their food, and their beds—are not yet regarded as "disposable ballast." But might they not too, *in extremis*, come to be *bouches inutiles*, to be driven out of the besieged town and handed over to the tender mercies of the enemy? If, then, one does not hear of comparative figures of airship-traction

costs as against those of aeroplanes, it is simply because no airship yet has ever attempted a commercial task. It is, indeed, singular how few are the tasks that have ever been attempted; and significant that there seems to be but one airship in the world to-day with which it is contemplated to continue even experimental flying.

Though the airship has not yet been set to commercial work, the story of the aeroplane is different. There are actual services that have been operating for years and are still operating. Sir Samuel Hoare, to the relief of many and the delight of all, has reached Karachi; it is but recently that Sir Alan Cobham completed his amazing performance; many other wonderful flights have been recorded. But when due allowance is made for the skill and courage of the pilot, the resources of the mechanic, and the immense knowledge and perfect practice that has gone to produce the engine and the plane, what is the practical utility of it all? Does not the wonder of these cross-continental and round-the-world flights really lie in the difficulties overcome, and not in the actual results achieved? Sir Samuel Hoare's journey is one of the few yet performed that is comparable in speed to the alternative ways of getting from the starting-point to the destination. Had Sir Samuel Hoare timed his departure to synchronise with that of the Indian mail, there would, I suppose, have been only a few hours between his arrival at Delhi and that of the mails at Bombay. In few other cases has the speed of the airman equalled the speed of the tramp steamer.

It is only over short distances—that is, on point-to-point flights—that the speed of the aeroplane is greatly superior to that of a ship or superior to that of a train. One recognises, of course, that speed may at certain conjunctures be of vital importance. This possibility

may justify a national subsidy to keep civil aviation in being. But if the nation chooses to keep it going, it should be for reasons that can be clearly stated. We should not be fooled into thinking that in time it will pay.

How about the aeroplane in war? If national emergency may justify the maintenance of a means of highly rapid transport, clearly this emergency—we shall be told—must be constant in war. Looking into the future, it must seem to most of us utterly inconceivable that any nation could be considered armed on land or at sea if it neglected to use the air, both to help its land and sea forces, and as an independent arm. On these propositions, I take it, almost all men are now agreed. Yet the precise task of the air is worth analysing. In the late war Germany alone had long-distance airships; and both on land and at sea their failure was complete. Most naval students supposed the value of Zeppelins as sea scouts would, in favourable circumstances, be incalculable. The singular thing is that this was not so. One such message only reached the German Commander-in-Chief. And that one proved wholly misleading.

But who that remembers the thrilling tales of Homeric fighting above the lines, that reached us after the trench war began and lasted till the trench war was over; who that read the story of how Zeppelins were shot down and bombing planes driven off, can be expected to doubt that in future wars air fighting will be not less, but more important than ever before? I venture to think, if there are any so bold as to doubt, that their numbers will be increased by a high percentage of Neon's readers. In the chapters which examine the performances of aircraft in the war, the cold logic of our author's facts shows that, despite all the heroism and skill, despite the

hideous casualty list, and the enormous sacrifice involved in the wealth and man power devoted to this arm, the actual contribution of air fighting to victory is pretty hard to find. Indeed, it almost looks as if these sacrifices came near to giving victory to the enemy. Until the trench war began, little was heard of the air. The moment the war of movement was resumed, the air arm faded into insignificance. Does it not look as if the war that was carried on in the air was really a diversion only? Nature hates a vacuum, and her children, men, are impatient of a deadlock. Did the air war, like the submarine war, come into existence only because no other form of fighting seemed possible at all?

The airmen neither warned us of the great attack of March, 1918, nor could help the army when the attack began. They could only "watch" it dazed by their own impotence. What would then have been the value *in the line* of all the men immobilised by the Air Service and its supply? That aeroplanes must have, and will have, a value in war, is just as certain as that they have a value in peace. But in both, their value can only be proportional to their efficiency as vehicles. As in civil aviation, so in military action. Steam and petrol and horses have left gaps, and in military life as in civil those gaps are narrow, and aircraft can fill them but seldom; and to be *always* ready for *every* chance of filling them, is a luxury for the prodigal alone.

These, it seems to me, are the conclusions to which the reader of this book is inevitably driven. There may, of course, be qualifying facts that have escaped Neon's eagle eye. There may be laws governing flight to which attention has not been directed. New physical properties may since have been discovered. They may be discovered at a future time. But it is difficult

to say which of these hypotheses is the more improbable.

And so one finds oneself faced with the master puzzle, how are we to explain the fact that an impoverished nation, crippled by debt, industrial disputes, and unemployment, can afford to spend over twenty millions a year on an activity the proved practical value of which is so very small? What has led us into spending on so uncertain a luxury half what a few years ago we spent on the Navy? What keeps us at this spacious spending now? The official pronouncements do not really help us—for when they are specific they are contradictory, and when they are not, they are without meaning at all. I have ventured on the suggestion that the bright young conjurers of Kingsway have been over-calling their hands, and, as is the case of those who have this disconcerting habit at the card table, this over-calling has followed no principle. The successive callings have, indeed, been apt to be mutually destructive. At any rate, what is said by those to whom the young enthusiasts supply matter for their speeches, leads one so to think. There is an airy inconsistency about the advocates of a large air policy, when they are out to prove its coming supremacy in peace or war, so startling and so persistent as to make one wonder, if the metaphor may be used, whether they have not missed their mark and are all at sea. It would, of course, be absurd to hold the Prime Minister, Sir Samuel Hoare, Marshal Trenchard, Lord Thomson, or Sir Sefton Brancker, personally responsible for the technical accuracy of their statements. If they are to be criticised let it be for their strange hesitation in perceiving that the experts do not all, or any one of them always, tell the same story.

For example, we have Mr. Baldwin saying that our

Air Force must be equal to protecting this country from the attack of any air force maintained by a neighbour within reach. At first sight this looks quite a plausible standard by which to measure our proper strength in men and machines. It is the answer that any Cabinet Minister would give, knowing that he was on safe ground. But then in flying nothing is safe—least of all the ground. And so we next have Marshal Trenchard, who, with the directness of the bluff plain soldier, knocks the bottom out of the Prime Minister's case. He implies that to defend this country from other air forces is just the one thing which the Royal Air Force cannot do at all! In this, Marshal Trenchard was following a notable precedent. Mr. Churchill, it will be remembered, at the outbreak of war cheerfully informed the War Office that it must not look to the British Navy to safeguard the shores of England. The military *raison d'etre* of our Air Force seems on this alone to be anything but clear to those responsible for national defence.

Now take the case of airships. It has been suggested that these are to have a considerable war value, while the expectations of their Imperial services have been put pretty high. A suggestion, welcomed with enthusiasm by successive Governments, is thrown out that the Ministry and a private company should co-operate to produce two five-million cubic foot machines to link the Empire together, so that the further point, New Zealand, shall not be more than fourteen days away from London. This involves crossing all the tropics that there are, and at a point—the neighbourhood of Java—where thunderstorms are not the exception, but the rule. Of the behaviour of airships in the tropics—that is, their conduct other than when struck by lightning—no one in the world, Sir Sefton Brancker says, knows

anything at all. What more reasonable than that one of our post-war airships—one that had been completed, but hardly yet flown—should be fitted out, sent to Egypt, and used to collect the data so totally wanting and so vitally necessary, before this great adventure of Empire linking can prudently be undertaken? The order is given, much money is spent. We are, you see, to proceed on scientific and commonsense lines. But within ten days of an official pronouncement that this experimental flight is essential, it is incontinently cancelled. The unknown data, we are told, might indeed be useful. But why bother about a little thing like that? We will assume that it will be all right "on the night." And after all, what is our Research Department for, if it leaves us, like King Canute, powerless to order the rising tide to fall? So the building of the great craft goes on; the Dominions' Premiers are invited to inspect the plans; we have columns about the provision of comfortable sleeping quarters and dining and smoking saloons for 100 passengers—just as if everyone did not know that the proposed ship cannot even theoretically carry the proposed weight; that it is simply madness to send one loaded across the tropics with pilots ignorant of all the elements that make other navigation safe; and that to pass through the thunder belt with the ship unprotected from instant combustion is more akin to suicide than mere folly.

Now take the case of Sir Alan Cobham. The Minister for Air, inspired no doubt by the adepts of Adastral House, said his performance was conclusive of one point, long in debate. It was the harbinger of a commercial conquest of the world by aeroplane! And not only that, it ensured the Air Ministry being the chief focus of travel and transport in the future! What a prospect! But

this was too much for the truthful Sir Alan. There was, he told us, no possible commercial future for the aeroplane at all. The value of his flight was that it proved the plane to be militarily supreme! Just that, and nothing more. The commercial air triumph was reserved for the airship. Now note a curiosity. Sir Alan is a really great exponent of civil—but not profitable—aviation. He is not of the R.A.F.; he is not an airship expert. His faith, therefore, in the fighting future of the air and in the trading future of the airship is unshaken in either case by practical knowledge. But he does know all about aeroplanes as a means of transport and travel, and he can be trusted when he says that there is simply nothing in it.

Similar contradictions abound in Neon's collection of evidence. Indeed, the strange thing is that in this indictment, compacted of evidence that can hardly be shaken, there is scarcely a single quotation from one who is hostile to the purpose for which the Air Ministry exists. If the propagandists are condemned, it is out of their own mouths. It is they who have created this chaos of conflicting opinion.

It is of course a symptom, and the disease can readily be diagnosed. There is no doctrine behind our Air policy, or rather, as each untoward thing happens, a new theory has to be produced. When R.33 was just saved from ruin by a lucky shift of wind, the crew were congratulated by Sir Samuel Hoare for having saved the future of airships by this most fortunate escape. Another wreck and the whole business would have been done for! Does our policy really rest upon so frail a hazard as this? Does it mean that there is no policy because there can be none? Are our spokesmen subconsciously aware that the present limitations of the airship and the

aeroplane as vehicles are fatal to their playing a great part in peace or war—and so must either find new arguments to meet new cases, or get rid of the limitations?

Fortunately or unfortunately, there is, however, one capacity of the aeroplane which is not in dispute, and on this some advocates of its military value have fastened. It seems to be the only thing on which, most lamentably, all the experts are agreed. It has accordingly become the corner-stone of our military policy. There is nothing vague or tentative about it. The plan is naked; and hideously unashamed. The singular mobility of the aeroplane is to be put—if the solecism may be excused—to a still more singular use. Our enemy's undefended towns and villages are to be bombed; the non-combatants coerced into calling off the combatants. We, of all nations, that is, have come to this. We are to put our faith in frightfulness. Were this our real creed, surely better means are at hand. The long-range guns of the Navy could flatten out more towns, and kill and maim more women and children in a one day's coastwise cruise, than all the squadrons we are ever likely to possess could manage in all the flights they could ever make. The education of naval officers, it is true, would need a few modifications before such tasks could be counted on as congenial. But are not airmen Englishmen too? Let us examine this proposal a little more closely.

I have already asked the question whether, rightly looked at, the theory that there could be a war in the air did not arise out of the succession of sky combats, that thrilled us from the beginning of the immobility of the armed forces until freedom was restored. That was, indeed, not only a kind of air war, but a war that had the

knightly note. It was a war of single combats, to which champion challenged champion. These combats had the mark of chivalry. The sheer bravery and skill of the thing brought back to a war already disfigured by a hundred lapses into barbarism, those momentary detachments from mutual hatred on which the epic poets and the chroniclers love to dwell. It was not the peaceful public only, it was the armies that stood still, gazing till the issue was known. If all this was diversion, it was a magnificent diversion. It restored some respect for an enemy not otherwise worthy of respect. But it was not war. The aces fought and fell. But there was no panic when they fell. The deaths of Goliath and Hector were great military disasters. In losing them, their fellows lost half their strength. We might lament our heroes of the air, but we knew that their survival or their perishing could not affect the final decision.

But there was another air war that went on the while. It was not chivalrous. It was not magnificent. It also was not war. It was no more war than were the unwarned sinkings by submarines, "leaving no trace"; than the Battle Cruiser raids on the East Coast towns, and the aeroplane and Zeppelin raids on London and Hull. These, like the air fights over the lines, grew out of the immobility of the enemy's sea fighting forces. But there is nothing epic about indiscriminately slaughtering non-combatants. Nothing, that is, except the stoic courage of the survivors, the *saeva indignatio* that made first the nation attacked, and finally all the world, sternly resolute that, cost what it might, the foul thing that caused these things must be ended once and for all. Have we forgotten all this?

There are certain things to be borne in mind about

methods of barbarism in war. To begin with, there is nothing modern about them. They do not embody any new military principle. They are not examples of any logical extension of the science of applied force. Indeed, it is their abandonment that is modern. And they have been abandoned, partly from a common feeling that they are revolting, but more because this feeling is backed by right sense. Hence, our own anger with the baby-killers was far from being our only reaction against frightfulness when we were its victims. For we had learnt something from our long championship of the rights of sea power, and our long apprenticeship to its duties. For two centuries and a half we had maintained the principle that war at sea could be conducted on ordered lines, and we had, indeed, so conducted it. Only the armed ships of the enemy could be attacked, and only armed combatants killed. The lives of non-combatants, enemy as well as neutral, were ever sacrosanct. If their property was forfeit, it was only when such property was destined for the enemy's comfort or support. Our methods on land did not conform to our sea standard until a century ago. But we set a good example then. Wellington was, I believe, the first European commander to pay for every requisition from the civil population, whether nominally friendly or professedly hostile, and the first to punish by death the man who stole a hen or assaulted a woman. We are not to suppose that the Iron Duke had men enough to spare for mere vindications of good morals. He acted ruthlessly, because in defence of a vital military principle, simple and obvious enough to us now, but not so clear then. He saw, first, that licence and cruelty would wreck the discipline that makes good soldiers; next, that atrocities would rob him of a sympathy the value

of which might, at any moment, be incalculable. And he saved the Paris bridges and Napoleon's Arch of Triumph from Blücher, not because he loved the French, or thought the monuments too pretty to spoil, but because, when the fighting was over, he wanted the war to be ended altogether. He would have no unforgivable acts of vandalism spoil the peace, any more than he would have useless and rankling cruelties spoil the war.

More exactly stated, the true military argument against attacking non-combatants is this. The issue of war is decided when the armed forces of one side are destroyed or paralysed by the armed forces of the other. The first of military maxims is to concentrate on securing this ultimate victory. The reader will remember the dispute between the Westerners and the Easterners in the recent war. The case against sending so large a force to Palestine was that it weakened the force in France, where alone, it was said, victory could, and therefore should, be sought. The Palestine adventure, the argument ran, involved dispersion—that is, waste—of power. I am not concerned to suggest which side had the best of it. But unquestionably it is the fallacy of force misused that condemns attacks on non-combatants. No country's resources are limitless. If you expend your money and your effort on planes—the costliest of munitions—for bombing civilians, you weaken to that extent the pressure you can bring upon the enemy's force. The argument for frightfulness is that you gain more by spreading terror in the nation behind the army than you lose by your resulting weakness in the decisive battle. But in the great European War frightfulness did not have this effect. It had, as we have seen, one diametrically opposite. And as the pages of Neon show, some of us have tried this form of

frightfulness since, on the Indian frontier, in Syria, and in Morocco. The results seem to be no better than our masters, the Germans, were able to get. Apart, then, from all other considerations, the thing must be abandoned now as a thrice proved failure.

Finally, indeed, looking at all the chaos, all the conflicting dicta here collected, one is left wondering whether the only explanation of it is not to be found in a lurking belief that while the laws of nature, of military science, and of ethics, seem, for the moment, to be set in hostile array against our aerial mania, there is yet a hope that the laws of nature at least may be changed or bent to the Ministry's will, and that any excuse or theory is good enough for keeping things going meantime. Is not this hope, in fact, almost the professed function of the Department of Research ?

The struggle between the sound economists and the politicians of all parties turns on a simple truism. Neither all industry, nor any industry, can be governmentally run or controlled, because industry is the outcome of an immense number of acts of enterprise, not one of which is conceivable when any of the elements which constitute enterprise are wanting. It is these elements that are the mainsprings of discovery, invention and creation. But these elements do not and cannot exist in any State organisation. It is this limitation that marks the chasm between what a Government can and cannot do. It cannot create. It can use the creations of individual enterprise in the public service.

It does conduct national defence. It maintains civil order. It runs our posts, telegraphs, and telephones. And although it conducts them all with an inefficiency that no Board directing a public Company could survive,

we have learnt to expect nothing better and are reconciled to the muddling, the injustice, the time-serving, and the insincerities that can with difficulty be eliminated from public action. We have to admit, too, that the State can equally take over and conduct—with a similar inferiority to present methods—the whole of our railway services, some of our insurance and a great part of our banking. But none of these activities are industrial. Transport, insurance, finance, these are the servants of the manufacturers and the traders who, in the last resort, are the creators of the wealth that supports the nation, and supplies the capital essential to its future support. Manufacture and trade consist, as has been said, of a multiplicity of acts in each one of which is found all the factors of enterprise: a forecast of future conditions; a definite plan; the will, and the capacity to carry the plan through; the risking of past savings—that is, capital—which must be put to the touch before the enterprise succeeds—or fails. And these factors, which must all be present together, can only exist in a single individual, or in a group conducted by a single will.

Of all forms of enterprise, that which is the most wholly personal is the gift of suddenly perceiving what is hidden from other men. It is this rare gift that we recognise to be the peculiarity of those pioneers in discovery and invention who are the true authors of modern progress, the great benefactors to whom we owe the immeasurable material advances of the last century. This is fundamental work, and is as individual as genius in poetry, music and painting. It is no more possible for a subsidised body of State investigators to emulate Newton, Faraday, Watt, or Lister, than for the art schools, the faculties of literature, the conservatoires, or Dartmouth

to add a Rembrandt to the National Gallery, a sonnet to Shakespeare's sequence, a prelude or fugue to the immortal Forty-Eight, or a Nelson to the Navy List. If, as I suppose, the true explanation of the babel I have been considering is that the Air Ministry is hanging on until some new force or some new substance is produced by its Research Department, then the answer is obvious. If it is the Almighty's wish that a genius capable of such fabulous wonders is to appear for the greater happiness of mankind, then, and only then, will the hidden secret of air success be revealed. For a Government Department to aspire to such providential powers is not mere presumption. It almost looks like demoniac possession.

Neon's achievement, then, seems to me to promise more than the mere clearing of our thoughts on the subject—fascinating because so mysterious—professedly discussed. Our air policy is the offspring of the most astonishing of human inventions. Its snipe-like twists and turns should not surprise us when we remember the magic influences which first fathered, and now sustain it. If seeing it for what it is, we see too how it is sustained, may we not have learnt a lesson which will have wider and not less fruitful applications? Is not faith in the Omnipotence of the State the most general, the greatest, and the most dangerous of all delusions?

ARTHUR HUNGERFORD POLLEN.

8*th January*, 1927.

POSTSCRIPTUM

I SEEM haunted by apt instances. Last night the B.B.C. set a fascinating puzzle to its listeners. A passage from Dickens was read to us three times in succession, and judging by the voice alone, we were to identify the age, sex, and profession of each speaker, guess whether he or she was a leader of others, and account for the differences in accent. This morning the Geneva correspondent of *The Times* suggests a puzzle even more intriguing. It is to account for the authorship of the British declaration on disarmament.

Certain elements of difficulty are obvious. For example, speaking of Sea Power, the delegates declare the Navy of an island power to be maintained for two primary reasons. First, there is the safeguarding of its trade routes, commerce, and food; and secondly, the defence of its coasts and those of the outlying parts of its empire. Now, had the delegates got their doctrine from the Admiralty, it would have been stated very differently. They would have said that the Navy exists for one purpose only. That is in war to attack and destroy, or by threat of attack to immobilise the enemy's fleet. With this disposed of by victory or neutralisation, our sea services are secured, which means that armies can be landed and kept supplied, and that the civil population is assured of food, and of the raw materials it can convert into the munitions needed by the armies. The Admiralty, that is to say, would never have led the delegates into the quaint mistake—long ago detected by Admiral Custance—of mixing up the consequences with the cause.

The problem, therefore, is to guess the writer's age, profession, and sex; to account for the extraordinary accent employed; and to say whether it indicates past or present leadership, and if either, of what conceivable body.

Now let us pass on to the Air Force. First we are told that the air is "a medium free from the limitations which necessarily limit the action of land and sea forces." Limitations, of course, very often limit. It is their nature. But it is wonderful to hear that the air is free from the limitations that circumscribe the action of armies and navies. If this is true, why waste money and effort on forces so unfortunately restricted? And for that matter, has not the air a few rather embarrassing limitations of its own?

But hear the delegates again. It follows, they continue, "that a maritime country . . . must possess an air force which is sufficiently strong *to repel invasion*" (italics mine). Now they cannot, of course, mean invasion by sea, because the first young lady speaker—which ministry, please?—has only just told us that this is the primary purpose of the Navy. Are we, then, to be militarily invaded by way of the "medium free from the limitations which necessarily limit the enemy's armies and fleets"? It is a horrible, but intriguing prospect. Or is it to be invasion in the sense only of bomb attacks from the air? I confess my imagination cannot rise to the first alternative. The delegates must then have the second in mind. And it is here that the problem of authorship comes in. It cannot be Adastral House that has made this priceless contribution to military wisdom, for one remembers that Marshal Trenchard has taught us that the R.A.F. is not a defensive, but purely an attacking force!

A. H. P.

18*th January*, 1927

CONTENTS

APPENDICES

"*There are two levers for moving men—interest and fear.*"—NAPOLEON.

"*Ignorance, static and inert, is bad, but ignorance in motion, as Goethe once observed, is the most terrible force in Nature, for it may destroy in its passage the accumulated mental and material capital of generations.*"—The Prime Minister, *Edinburgh University*, 11*th November*, 1925.

"*When we go to decide upon a subject without troubling to really examine what it is, then at best we only inform ourselves of what is said about it; and our judgment of it will be founded on nothing more than a sort of pretence or imagination not reflected by the facts. If there is error in the reports we rely upon, then that error becomes our own; and this again in its turn confirms error in others. The mistake of one becomes a public mistake, and then it is consecrated; so that he must needs be a bold man who would question it, or even refuse it subscription.*"—Mason, "*The Art of Chess.*"

FOREWORD

Since the conclusion of the late War, and increasingly during the past few years, belief in the future of the Air has been ceaselessly fostered in the public mind. As a result of importunate propaganda the nation as a whole acquiesces in the strange doctrine that aircraft are of vital importance for transport in peace and will prove the decisive factor in 'the next war,' so the country, therefore, must be supreme in the air, no matter at what cost. Supremacy in the air is to be regarded as the substitute for that chivalrous supremacy at sea—that maritime command—which in the past, without violence to non-combatants or property, and without acts of shame, has made and retained the strength and greatness of this country.

It is doubtful if there is any historical parallel for the volume of feverish propaganda to which this country has been subjected. Its repercussions have been so great that other nations are following our lead, and all are witnesses to a terrible race for what is called 'air supremacy.' Even coloured and semi-civilised peoples are becoming dominated by the grisly phantom of the Air.

Perhaps the most remarkable feature of the country's enslavement to this false idea is the absence of any clear or systematic opposition. Air schemes, no matter how fantastic or foolish, remain uncriticised. Though public enthusiasm for the Air is obviously lacking, an almost fatalistic acceptance of its necessity has settled down upon the world at large. This absence of interest and enthusiasm explains the obvious and indeed very natural anxiety of the Air Ministry to kindle and arouse what is clearly lacking. The Secretary of State for Air, Sir Samuel Hoare, says:

> "We must get men and women in all walks of life thinking of air problems,"

and Air Vice-Marshal Sir Sefton Brancker, Director of Civil Aviation, has emphasised the reason:

> "They were now evolving a policy, but it needed money, and money meant public support; therefore the education of the public was a matter of the first importance."

Public support for air schemes will need to be very substantial, for the cost of aircraft and all air operations is enormous.

When airship operations ceased in 1921 we had spent, according to Sir W. Joynson-Hicks, £40,000,000 on airships and their accessories. Now the Government has embarked on a new and ambitious airship policy, and many more millions will be required. Two giant airships, the R.100 and the R.101, are to be constructed and tried out on the Eastern route. Already the cost of this new airship development has exceeded £850,000, yet these airships are scarcely out of the design stage, their construction has yet to be taken in hand, the airworthiness of airships has still to be proved.

Since 1919, when this country had an abundance of pilots and aeroplanes of all kinds, £160,000,000 has been spent on our Air Service, yet while our 'Air Defence Force' cannot provide any sure defence against air attacks, it undoubtedly invites, by its very policy, bombing attacks upon our shores.

Civil Aviation is carried on at great expense to the State: since 1924 the estimates have amounted to £1,243,025. The cost to the taxpayer of every mile flown by Imperial Airways in 1926 is 3s. 4½d., and the extensive alterations and improvements to the aerodromes at Croydon and Lympne are an extra charge upon the State. In the first year of this Company the working loss amounted to £152,217, and in the second year £157,424, but the subsidies received from the State reduced these losses to £15,217 and £20,414 respectively.

Aerial Sporting Clubs receive State doles. The sum

paid for 1925 was no less than £22,000, for a membership which is stated to number 525 flying members only. The avowed object of these clubs is to popularise aviation and to create a reserve of pilots for war. The usefulness of aircraft in peace and their fearsomeness in war is thus steadily inculcated, and the resulting belief in both has provided rich fields for the cultivation of varied and powerful interests.

Cool and dispassionate consideration of the facts will show, however, that 'air power' is illusory and 'air supremacy' a will-o'-the-wisp. The development of aircraft for war purposes is a sheer waste of men and money, and moreover constitutes a grave danger, since expenditure and dependence upon unreliable and futile weapons is a sure road to defeat.

It will be shown that airships can never be safe or practical as commercial long-distance vessels, and that they are useless in war; that aeroplanes can never be made to pay in peace as passenger or freight carriers, and that in war they have proved themselves to be unreliable, ineffective, and unprofitable, no matter how brave the pilots or spectacular their exploits. While prodigal of life and treasure, aerial warfare has only succeeded in sowing mistrust and enmity, breeding fear, encouraging frightfulness, provoking thereby a manifest return to barbarism.

The late Prime Minister, Mr. Ramsay MacDonald, has truly said: "The more democracy advanced the greater were the drafts made upon the intelligence of the people, their good judgment, their capacity to reflect and to refuse to believe silly nonsense, whether it fell from people's lips or appeared in the columns of newspapers, and their capacity to use their powers as rational men and women. Upon that depended the greatness of States and the future of our history." But the public have little to guide them in the consideration of air problems; therefore the Author has essayed to deal with the subject in its many aspects by stating the facts in

simple language, trusting that men and women in this country will reflect on these matters, be convinced of the truth, and become alive to all that an appreciation of the truth implies.

If this book, undertaken in no partisan spirit, contributes to the saving of valuable lives and treasure and assists in the appeasement of fear and international mistrust, it will not have been written in vain.

* * * * *

The Author has treated the question of airships and aeroplanes separately, for air enthusiasts are themselves divided on the merits of lighter-than-air and heavier-than-air craft. Those who appreciate the shortcomings of aeroplanes look to airships, and those who realise that airships can never be made practical vessels, hope that experiment and research will remove the inherent disabilities of aeroplanes and make the impossible possible. Readers may find that certain facts and statements recur, particularly in the discussion of airships. In each case the bearing of the fact upon the point under discussion has a special significance, and it has been found necessary to deal with points which at first sight may appear unimportant.

This book had its genesis in the breakaway of the R.33, an incident which made it plain that the fundamental distinction between *winds* and *currents* was not understood. The Air Ministry, concerned with the cultivation of 'air sense,' did nothing to dispel this misunderstanding of an overruling principle. Indeed, official language in connection with gales and their effects on aircraft has tended to confirm the error.

On the 16th October, 1925, an early draft of the airship portion of this book was sent to the Prime Minister as Chairman of the Cabinet Economy Committee, and was duly acknowledged.

One of the most important matters dealt with at the Imperial Conference, arousing the greatest interest, was

the development of Empire Air Routes and the problems of Air Defence. In December, 1926, shortly after the Conference—whilst this book was in the hands of the printers—an Air Ministry publication appeared under the title "The Approach towards a System of Imperial Air Communications." No point in connection with airships discussed by the Air Ministry in their publication has been omitted from consideration in this book: many vital disabilities, however, have been ignored in the official treatise, the outstanding feature of which is an apology and a plea for airships.

The distinction between winds and currents has been recognised and at last stated, yet the full significance of the fact is either not appreciated or, if appreciated, it is ignored.

* * * * *

Some words and passages in the quotations appearing in this book have been printed in *italics*. These are the Author's italics and are not to be found in the original text.

THE GREAT DELUSION

"Sit down before fact as a little child, be prepared to give up every preconceived notion . . . or you shall learn nothing."

CHAPTER I

INTRODUCTORY

THE LAW OF CURRENTS

THE basic fact is not generally realised that the movement of the air above the surface of the earth (called *wind* by landsmen, seamen, and meteorologists) is not felt as wind by aircraft afloat in it and completely surrounded by it. This fact not being generally recognised, its supreme significance is ignored.

Loosed from her moorings and free in the air, an airship ceases to be strained and buffeted by the wind where horizontal currents are concerned; the airship becomes part and parcel of the moving air in which she is immersed, entirely in accord and union with it; no longer offering any resistance to it, but at ease in it.

Dr. Eckener (who has been associated with the Zeppelin Company from the early days, and has been its Managing Director since the death of Count Zeppelin) alludes to the prevailing ignorance on the subject, and confirms this fundamental fact when he says:

> "The general public still imagined that storms represented a direct danger to airships in the sense that the lightly built ship must be destroyed in the air or badly damaged. Storms, so far as horizontal air currents were concerned, did not menace aircraft, which while aloft always underwent only that strain which was caused by their own movements through the air."[1]

This ignorance of the law of currents on the part of the public is perfectly natural, since they are, in general, unacquainted with the problems of navigation. It is most disconcerting, however, to learn that the Secretary of State for Air in the late Government,[2] who had the

[1] *The Times*, 28. 3. 1925.

[2] Brigadier-General C. B. Thomson, C.B.E., D.S.O., created Baron Thomson of Cardington in 1924, was Secretary of State for Air to the Labour Government, January to October, 1924.

benefit of technical and professional advisers, should not be acquainted with this simple and overriding law. In the last of a series of special articles entitled "Air and Empire," Lord Thomson makes the following remarkable assertions:[1]

> "The shape of airships and the large surface they expose to the action of the wind impose methods of navigation resembling, in some respects, those which obtain with sailing ships."
>
> "To drive an airship into a strong head wind would strain the structure, use up a needless quantity of fuel, and expose the passengers and crew to inconvenience and discomfort without any compensating gain in time."

Since *wind* exercises no pressure on an airship, the size of the ship and the force of the wind are immaterial so far as wind pressures are concerned, and the "action of the wind" on an airship is entirely different from its action on the sails of a ship: there is no analogy between them.

As perplexing and serious as Lord Thomson's non-comprehension of the law of currents is the fact that it seems to be shared by some of those who, at the present time, are shaping our air policy, for on no other assumption is it possible to conceive the suggestion of even approximate time-tables for long-distance airship flights. In truth it does not matter with what velocity or in what direction the wind is blowing, or, to transfer one's imagination and perception to air instead of land conditions, how rapidly, or in what direction, the horizontal air current is moving in relation to the earth below. The moving air does not disturb or strain the ship, for both the air and the airship are moving together in harmony and as one, and whatever is the rate of the wind relative to the earth, the speed of the air current relative to the

[1] In the *Observer*, 24. 10. 1926.

airship in it is always nil. She glides along with and in the air current, not conscious of its rate and direction, and unless she can sight land, make astronomical observations or obtain information by directional wireless, she loses her bearings and has no accurate knowledge of her position and course made good. She may go so far out of her way that she cannot return or make her port for lack of fuel.

The airman does not feel the wind or gale that is affecting the earth, though to a landsman looking up the airship appears to be "fighting the gale" and "riding the storm." The following is from the Log of the R.34:[1]

> "Weather fine—wind 40 knots S.S.W. (46 m.p.h.), sea very rough. It is difficult to measure the height of waves from above, but it is easy to see that in a very heavy sea like this a surface ship would be having a bad time. Up here we are as steady as a rock, and unless we look out of the windows, it is hard to realise we are travelling at all."

This simple law of currents applies equally to all objects floating and operating in air, whether airships, aeroplanes, or birds. It is not generally understood that birds in free flight feel no breath of the wind in which they are flying.[2] They feel a draught straight ahead equal to the speed of their own flight, and know only a calm so far as wind pressure is concerned, even in a strong gale. It may seem strange that the wild sea birds, apparently fighting their way into the gale, feel nothing of its force until they attach themselves to another medium—in other words, alight on the water or the land. Realisation of this simple if not obvious fact throws interesting light upon the habits, instincts, and flying powers of birds.

[1] "The Log of H.M.A. R.34," by Air Commodore E. M. Maitland, C.M.G., D.S.O., A.F.C., R.A.F., p. 104.

[2] In the light of this simple truth many ornithological books and 'scientific' articles on the flight of birds will be found misleading.

Birds in flight,[1] like all aircraft, operate in one medium only. They have been cited to exemplify a law known indeed to all navigators whose business lies with winds, tides, and currents, but not understood perhaps by the non-seafaring public at large.

An airship afloat must have her engines working to ensure her longitudinal stability—her balance—in the air, just as a submarine must work her electric motors to maintain her balance while moving under water. By the power given to the airship by her engine speed she makes her way through the medium in which and with which she is already travelling, and she feels no wind except what she herself creates by the propulsion of her engines. As has already been shown, she is, as far as steady horizontal currents are concerned, in a calm in the air; by her own motion through her medium she creates her own draught, and an observer in an airship feels this as a head wind exactly equal to the speed of the airship.

Imagine an airship[2] with a cruising speed of 30 m.p.h. steering south, and a wind blowing from the north 20 m.p.h. at 2,000 feet up. This airship moves through her medium at 30 m.p.h., and only undergoes the strain of this speed; but she, without any effort on her own part, is already going south with and in the air current at the rate of 20 m.p.h., so that she is making 50 m.p.h. *way* to the southward. An observer on board is conscious only of a south wind of 30 m.p.h., and at the same moment the landsman is feeling a north wind of 20 m.p.h.[3]

Take the case of the same airship, again going south, but the wind on this occasion, though of the same velocity 20 m.p.h., is from the south. The ship heads south,

[1] A letter on this subject by Commander B. Acworth, D.S.O., R.N., appeared in the *Spectator* of 20th November, 1926.

[2] The simple conditions of the elementary examples stated are given to illustrate and emphasise the fact that *wind* is a *current* to aircraft.

[3] To simplify the illustration the difference between the velocity of the wind at the surface and at 2,000 feet has been ignored.

making 30 m.p.h. through her medium, but the *way* she makes in relation to the land is another matter, for the airship and the air itself are flowing 20 m.p.h. towards the north, and therefore the airship makes towards her southern port at the rate of 10 m.p.h. only. Though she is making only 10 m.p.h. southward, the observer on board would feel, as before, a south wind of 30 m.p.h.—the rate the airship is going through the medium she is in. In short, *the wind that any aircraft feels, be it airship or aeroplane, is only and precisely just what she herself creates, and is always from right ahead.*

In the first case the ship is making good 50 m.p.h. to the southward, or 50 land m.p.h., and all is well. In the second case the ship is only making good 10 land m.p.h., *though she is using up the same amount of fuel.*[1] Whether she will ever arrive at her destination, if the same general meteorological conditions continue, will depend upon the amount of fuel she has in her tanks.

The following extracts are from the Log of the R.34 on her outward voyage to America, July, 1919:

> *5th July*, 12.20 *p.m.*—"The petrol supply is distinctly serious. We cannot now afford to run all five engines at once as they would eat up too much petrol. We have got 500 miles yet to go to New York . . . if we get much wind against us we are done, and will have to be taken in tow by a Destroyer or other surface craft during the night (humiliating thought !) —the idea being that at dawn we would cast off and fly into Long Island under our own power."
>
> *6th July*, 12.10 *a.m.*—R.34 sends message to U.S.A. Naval Air Service: "If through shortage

[1] The two examples given allow the airship a speed in excess of the current, a condition not always obtaining. Suppose an airship headed due north, 'steaming' 50 m.p.h. through the air, is in a north wind—that is to say, in a south-going air current. Suppose also that the velocity of this south-going air current is 60 m.p.h., or 10 m.p.h. swifter than the engine speed of the airship. Under these circumstances the airship headed north and 'steaming' 50 m.p.h. will, in fact, be travelling south at the rate of 10 m.p.h.

gasolene R.34 wishes to land Chatham, can you supply 50,000 cubic feet hydrogen, and 500 gallons gasolene ?"

6th July, 4.25 *a.m.*—"The petrol situation has now become desperate, and Scott decides he must land at Montauk for petrol."

7.20 *a.m.*—"Passing U.S. Naval Airship Station, Montauk, Long Island, with nice following wind. Our luck is in after all. We are making good speed, and find we can just get right through to New York. What a relief !"

9.40 *a.m.*—"We have 140 gallons of petrol left, or two hours at full speed, so we couldn't have cut it much finer, and are lucky indeed to get through !"

Lieutenant Shotter, the Engineer Officer, stated after landing:

> "I shall never forget the last fifty hours of our flight. Early on Sunday morning (6th July) . . . Major Scott asked me to see if it was not possible to scrape up enough petrol to carry us through. I organised a search party. We made a careful inspection of every fuel tank on board. We carry eighty-one of these tanks, each holding nearly 70 gallons. With all the utensils we could find that would hold petrol, we went from tank to tank. I myself carried one of the pots we used for cooking. Well, we managed to pump, scrape, and scour enough petrol to carry us here. When we reached here we had enough to have flown twenty minutes longer."[1]

This emphasises the all-important fact that even if an airship fills up to her utmost lifting capacity in fuel, as did the R.34 when she "got away with 4,900 gallons of petrol," she may still not have enough fuel to reach

[1] *The Times*, 10. 7. 1919.

her port, for what currents an airship may encounter in a voyage cannot be predetermined.[1]

As regards the construction of an airship, she must be built strong enough to stand the strain of her engines going at full speed and the stresses due to gas-bag pressures, and she must be able to turn about without breaking her back; she must be strong enough to withstand the stress and strain of *vertical* currents, particularly violent in electrically disturbed areas[2]—these are superimposed upon the horizontal currents and in addition to them, and may be likened to the waves of the sea to a ship; and the airship must be able to stand the stress and strain of the wind *when moored.*

The material best suited for the hull and lattice work of an airship,[3] combining soundness, durability, and strength with a minimum of weight, is a matter of importance and concern, but whatever material is used, it can be stated generally that the stronger the ship is built the heavier it is, and the less margin of weight will be

[1] Referring to the Polar flight, Colonel Nobile of the Airship *Norge I.* said: " Most depends on what happens on our 2,000 miles journey to Alaska. If we have a strong wind against us, we must face the fact that the whole of our 7 tons of fuel may be consumed. We cannot replenish either petrol or hydrogen, and in that event will have to land on the ice—or it may be we shall have to land on the sea. One cannot tell." (*Evening Standard,* 13. 4. 1926.)

[2] Apart from thunderstorms, " the most serious condition of vertical air velocity is to be met with in and around cumulus clouds." " Cumulus clouds should be considered a warning of danger and should be avoided." (*J. of the R. Ae. S.*, June, 1924, p. 383.) But, at the inquiry into the loss of the U.S. Airship *Shenandoah* it was held " that the cumulus clouds are the result of these (vertical) air currents and not the cause, and that therefore the rising currents may be well established before the clouds develop." (" Technical Aspects of the Loss of the *Shenandoah,*" p. 665.)

[3] The metal which has hitherto been used for airship construction is *duralumin,* an alloy of aluminium. This alloy is a German patent, and the rights in this country have been secured by Vickers, Ltd.; it is said to be brittle and particularly susceptible to failure by reverse bending. The ' Burney ship ' will be made of duralumin, whereas *stainless steel* is to be used for the girder work of the R.101, the Air Ministry vessel.

left for useful load. As a result of the breakaway of the R.33, 60 feet of nose has been reconstructed. This new nose is twice as strong as the old, and weighs 5 cwts. more; in consequence the airship can now carry less, and were she a commercial ship she would have to give up about 75 gallons of fuel or take 5 cwts. less useful, or paying, load.

If the ship is built so as to have a good disposable *lift*, she is likely to be too lightly constructed to stand the strains to which she will be subjected, and she may break completely asunder, as did the R.38 while manœuvring over Hull on the 24th August, 1921, when forty-four brave men, including Air Commodore E. M. Maitland, lost their lives.

The method of anchoring the ship to the mast is a matter of great moment, as is also the strength of the nose of the airship, and the position of the control car. The method of mooring which has hitherto been adopted is from the point at the extreme end of the nose, allowing the ship maximum freedom of movement. The nose must be strengthened for this attachment, but, as is pointed out, the nose must not be made too strong, for that would merely transfer the breaking-point further back, where it would be infinitely more dangerous. A new method has been evolved by Commander Burney,[1] and will be incorporated in the R.100. This ship is to be held at two points (one on each side), and though, as it is admitted, this method will set up stresses in rolling owing to lack of freedom, it is designed to leave the nose space free. The primary control car is to be placed in the nose of this ship—a position viewed with apprehension by aeronautical engineers—and Commander Burney proposes to put a secondary control in the usual place "until experience of the alternative position of the control car in the nose has been obtained."[2] In the R.101

[1] Commander C. D. Burney (Retired), C.M.G., R.N., M.P. (Airship Guarantee Company and Messrs. Vickers, Ltd.).

[2] *The Times*, 21. 4. 1925; 25. 4. 1925.

(Air Ministry type) the control car is designed to be in the normal position akin to the ship's bridge.

Constructional engineers declare that:

> "The calculation of the stresses in an airship structure is a complex matter . . . in dealing with aeronautical structural design the degree of refinement of methods of calculation called for is in excess of that adequate for other branches of engineering; this arises because it is not possible to afford the usual large factors of safety."[1]
>
> "The final judgment of the structural strength of a rigid airship rests ultimately upon experience which we cannot yet pretend to have acquired. Academically, if we know, first, the external forces to which the ship in service is subjected, and secondly, the stresses induced in the structural members of the ship by those external forces, we might assign with confidence the factors of safety which are usual in engineering structures. However, the matter will never be so straightforward as this."[2]

[1] Aeronautical Research Committee, Reports and Memoranda, No. 775.

[2] "The Strength of Rigid Airships," by C. P. Burgess, J. C. Hunsaker, and S. Truscott, in *J. of the R. Ae. S.*, June, 1924, p. 421.

“First principles prove and are not proved.”

CHAPTER II

PRINCIPLES OF TRANSPORT AND NAVIGATION

1. *Any practical vehicle of transport must have a power of motion much in excess of the rate of any possible movement of the medium on or in which it operates.*

All vehicles of transport on land—trains, motor-cars, bicycles—move on a fixed medium, the earth, and through another, a volatile and unstable medium, the air; to such vehicles movement of the air acts merely as resistance or assistance, according to the circumstances.

Steamships move partly in and through water, a dense medium relatively fixed; and partly through a second medium, the air—a gas—the motions of which, called *wind*, may affect but cannot seriously help or hinder the speed of the vessel directly, except in so far as a great wind will raise great waves against which a ship must not be driven.

A sailing ship moves in water and in air. The water in which she is merely floating is relatively fixed: the great stream of moving air—the wind—passes her by, except that little volume which is caught by her sails; impinging upon the sails and checked by them, the wind provides the motive power which drives the ship along through the relatively fixed and dense medium in which her bulk is floating. The resistance of the water and the pressure of the wind upon the skilful—the seamanlike—set of the sails provides, within certain limits, motion in any direction desired.

Movements of the water (known as currents, or as tides when periodic[1]) in which a ship is embedded, must carry the ship along in the same direction and at the exact speed as that at which the water is itself moving, yet the

[1] The Nautical Tide Tables give the direction, change, and speed of the tides. With their strict periodicity all these factors of the tides can be accurately foretold.

current does not betray its presence, it exerts no pressure on the sailing or steam ship floating or moving freely in it.

Currents of the sea are comparatively constant; they are generally known and charted, and are trifling compared to the currents of the air, yet a knowledge of their rate and direction is necessary for safe navigation. Slight as these currents are, sailors know the significance and importance of the resultant *set* to which they give rise, for unsuspected currents, or known currents insufficiently allowed for, account for many of the disasters to sea-going vessels.[1]

An airship (like birds and all aircraft) moves in and through one medium only—the air.[2] The movement of the air in which the airship is immersed, must carry the ship along in the same direction and at the exact speed as that at which the air itself is moving, and as with ships in ocean currents, the air currents do not betray their presence, neither do they exert any pressure on aircraft.

The winds—the currents of the air—vary hourly from anything to 100 m.p.h. at the surface of the earth. They are consistently more rapid at flying heights than on the surface, a 15 m.p.h. wind becoming (more or less) a 25 m.p.h. wind at 2,000 feet up,[3] as is shown in the daily "Flying Forecasts." Over the tropical seas, where alone

[1] At the enquiry held on behalf of the Board of Trade into the stranding of the s.s. *Otranto* (11th May, 1926), it was found that "the actual cause of the casualty was a current which set the ship to northwards out of her course"; there was an error of "judgment in failing to make any allowance for a current which might have been expected." (*The Times*, 17. 7. 1926.)

[2] It will be appreciated from this fundamental fact, and all that it implies, that the oft-repeated analogy of an airship and a sailing ship is entirely false.

[3] This is a general condition only and should not be taken as a mere addition of 10 m.p.h. Commander Garbett of the Meteorological Office, Air Ministry, states: "When experiments were carried out over the English Channel . . . on one occasion it was found that a westerly wind blowing at 4 *m.p.h.* on the surface had veered 9 points at 3,000 feet and increased its velocity to 40 *m.p.h.*" (*J. of the R.U.S.I.*, November, 1925, p. 733.)

there is any regularity in the air currents, conditions are such at certain periods of the year as to render transport by airship peculiarly dangerous.

An airship afloat and free in the air cannot *hold her own* unless she has a power of motion in herself equal to the rate of the current in which she is operating: she cannot *make any way* unless she has a speed in excess of the current; and she cannot be a practical means of transport unless her speed is such that the rate of any current she may be in is relatively a small factor of her own speed. When the R.33 broke away from her mast she set her engines going and tried to hold her own, but the current she was in was so much stronger than her own speed that instead of remaining near Pulham she was carried sternwards 120 miles away in five hours. The helplessness of an airship with only 50 m.p.h. speed has shown the necessity of a higher speed, and a maximum speed of 70 m.p.h. is proposed for the two new airships of 5,000,000 cubic feet capacity which are to be built. The late Lieut. Du Plessis de Grenédan, Captain of the *Dixmude*, gave it as his opinion that 90 m.p.h. is a minimum below which speed should not fall, and that 125 m.p.h. is a more suitable speed for an airship.[1] Speed should be considered a requirement of prime importance.

Were the currents of the sea at times as great or greater than the speed that could be given to ships, and were their direction and rate for ever changing and therefore uncharted and unchartable, regular and reliable navigation of the open seas and oceans would be utterly hopeless. A long voyage could only be successful and, indeed, could only avoid disaster when fortune favoured: sea-borne trade and regular intercommunication between continents would be impossible, and that great part of civilization which owes its origin to the sea would be still unborn.

[1] *J. of the R.U.S.I.*, February, 1924.

2. *No vessel must depend for its navigation in open waters upon outside help, though near the coast, lighthouses, buoys, and beacons are valuable aids to navigation and pilotage.*

A sea-going ship by *dead reckoning* and observation of the heavenly bodies has constant knowledge of her position, within narrow limits, and with the aid of accurate charts can therefore know what course to steer. An airship when over land has no true horizon by which to *fix* with the heavenly bodies, and out of the neighbourhood of well-known landmarks she has no means of fixing her position from observations of the land, since the continents are not charted with a view to navigation. Existing maps of a country are on an exceedingly small scale and are quite useless for navigational purposes; even the Ordnance Surveys would only be of practical use to those who know and therefore can recognise salient features on the landscape: thus for lack of means for obtaining *fixes* whereby to calculate position, drift, and speed, the R.34 when over Nova Scotia worked out her "speed over the ground by measuring the shadow of the airship on the trees with a stop-watch."

The necessity for aircraft of clear landmarks and lighthouses on land is recognised. The French have erected a huge lighthouse near Dijon:

> "It is lit by one milliard candle-power—that is, more than thirty times the power of Grinez and Ushant lighthouses . . . the construction of this, the first real lighthouse for aircraft, marks the beginning of a great scheme for marking out the international air routes so as to make them available for long-distance night flying which is essential to the progress of commercial aviation."[1]

Another lighthouse of the same candle-power has since been erected near Paris. The cost of these lighthouses has not been stated.

[1] The *Daily Telegraph*, 21. 4. 1925.

When over the sea but in sight of land, an airship may discover her whereabouts by reference to charts.

When at sea the position of the airship can of course be calculated by observations of the heavenly bodies with a sea or cloud horizon, if the heavenly bodies and horizon are in sight at the same time. If the cloud horizon is quite flat, it often proves "a valuable rough guide, but it is easy to make as much as a 50-mile error in locating one's position."[1]

"Aerial navigation is more complicated than navigation on the surface of the sea owing to the existence of a third dimension." A ship afloat is always at sea level and on a comparatively non-transitory medium. An airship can estimate her height from the shadow she casts on the water or earth beneath or from the height of her own barometer, but without a comparison of a barometer at the earth's surface below her (be it sea or land) her height can only be guessed.

> "Until we know our exact height above the sea we cannot plot our exact position, so until we speak a ship in our vicinity and get her barometer reading we still lack means for such a calculation."[2]

On one occasion (noted in the Log of the R.34) the estimation of height by shadow worked out at 2,100 feet; by barometer 1,200 feet. Fortunately they spoke a ship:

> "Speaking s.s. *Canada* on our W.T. spark set. Another W.T. operator is trying to get her on the directional wireless. All we know at the moment is that she is somewhere within 120 miles of us and bound for Liverpool."
>
> "She gives her position . . . barometer 30·8 rising. Wind and sea moderate from S.E."

[1] "Log of H.M.A. R.34," pp. 18, 19.

[2] *Ibid.*, p. 44. Means have been developed of estimating height above sea by echo. This might prove satisfactory at sea, but over land the height of the land itself above sea level is likely to be an unknown factor.

"The reading on s.s. *Canada's* barometer is of the greatest value, and is exactly the information of which we are in need. We can now work out our true height above the sea, and consequently fix our exact position . . . *we get our height as* 1,000 *feet.*"

The s.s. *Canada* was 60 miles S.S.E. of the airship.

When at sea (even when the surface is visible) drift and speed can only be very roughly estimated:

"Whenever the surface of the sea is visible observations are taken with Drift Indicator to check our course and speed. This is also frequently checked by timing the ship's shadow when visible, in some defined spot, such as foam by a breaking wave."[1]

"Scott's method of estimating wind on surface of sea is to watch a wave breaking, when foam is left on the surface," and from observation, "a more or less reliable direction of wind on surface of sea can be obtained."

By night attempts may be made to estimate drift by observations of lights, and if these are absent, flares must be dropped on land or sea:

"Dropped a calcium flare which floated away straight astern . . . our speed is evidently considerable, but as no means exist of taking an angle of depression of the flare, it cannot be calculated."[2]

But clouds and fog may obscure the land or the sea below the airship, and to find out where she is—if she can—or her speed and drift, she may come down below the clouds, however inconvenient, undesirable, or dangerous descent may be:

11*th July*, 1919, 3.30 *p.m.*—"Still at 3,000 feet . . . we have not seen the sea since 8.30 this morning."[3]

[1] "Log of H.M.A. R.34," p. 48. [2] *Ibid.*, p. 117.
[3] *Ibid.*, p. 113.

Later—4.30 *p.m.*—" Scott brings his ship down to try for a glimpse of the sea and so get an idea of our speed, but at 900 feet it is still quite thick, and so he abandons the attempt. We have been in these thick clouds for some considerable time, and there is no means of telling our speed, as they extend right down to the surface of the water. We assume that the wind is with us; the worse condition we think fair to assume being no wind at all. There certainly ought not to be a head wind against us. No alternative but to keep plugging away through the clouds until other conditions appear."

Since an airship cannot know her position when neither land nor heavenly bodies are in sight, she must depend upon wireless telegraphy for this essential information,[1] and many powerful directional stations would be required for this sole purpose.[2] But wireless may fail through breakdown, atmospherics, and inter-

[1] " The Airship *Norge I.* flying from Oslo to Leningrad got into a zone of mist and could not tell its position, though the Commander thought the direction he was taking was the right one. The *Norge* asked Vaxholm to request other wireless stations to endeavour to obtain connection with a view to directing the airship." (*Evening Standard*, 15. 4. 26.)

[2] It is found that directional wireless observations, *as regards range*, are generally accurate up to about 100 miles on sea and 30 miles over land (*The Times*, 18. 8. 1925). In the proposed Eastern overland route from Egypt to India, many directional stations would have to be erected and maintained, for with the shorter range of accurate observation and the absence of handy ships below (fitted with wireless for their own convenience), essential aids to navigation are lacking on land that are available at sea. " A large amount of systematic investigation carried out with direction-finders during the last four years has brought to light many definite facts concerning the behaviour of these instruments in the process of ordinary wireless communication. Various objects, such as metal-work, whether above or below ground, trees, tuned aerials, and long stretches of overhead wires, might cause an error in the apparent direction, which might be as much as 50 degrees." (*The Times*, 2. 9. 1925.)

ference, and during a thunderstorm communication is cut off, for aerials must not be out:

> "Got a Directional Wireless Bearing on Clifden; but when we wanted another we could not get it, as they were not sending but receiving . . . it would seem that in the future, when their number would justify the expense, W.T. Directional Stations will be required solely for the use of aircraft."
>
> "We pick up H.M.S. *Cumberland* on our Marconi spark set. She gives her position and, when plotted on chart, Cooke thinks she should be almost due north of us, and, from the strength of her signals, within thirty miles. Durrant tries to get her on the Directional Wireless, but without success."[1]
>
> *4th July.*—"X's very bad. Phones burn out. Rigged up new pair."
>
> *Later.*—"Cannot read through X's."
>
> *5th July*, 2.15 *a.m.*—"Atmospherics terrific, but watch still kept."
>
> 2.30 *p.m.*—"Second pair of phones burnt out. X's very strong."[2]
>
> 6 *p.m.*—"Had to haul in aerials as attempts to use wireless resulted in 2-inch sparks owing to highly charged atmosphere."
>
> 9.20 *p.m.*—"Aerials again lowered, but they charge up too quickly and are at once reeled in."
>
> "Our wireless on 1,400-metre wave is being jammed by local spark vessels."
>
> "Clifden jammed by small boat underneath saying: 'You are on our port bow.'"

The safety of the R.33 during her forced flight in April, 1925, was stated to have been imperilled by users of wireless ashore. Messages from the airship at one time could not be received intelligently at Croydon and Pulham aerodromes owing to the excessive interference that was experienced. The consequences of interference

[1] "Log of H.M.A. R.34." [2] *Ibid.*, Wireless Log.

with aircraft in danger are so grave that the Postmaster-General issued a warning to wireless users.

For the Polar flight in April, 1926, the *Norge I.* was equipped with specially designed wireless apparatus so as to maintain communication with the outside world during the whole of her voyage, yet even on the journey between Oslo and Leningrad, owing to unfavourable meteorological conditions, wireless communication was interrupted. When in touch with Vaxholm radio station during the early hours of 15th April, the *Norge* reported being fogbound in mid-Sweden. Her Commander thought he was steering a correct course. When the *Norge* passed over Trosa, south of Stockholm, she was flying eastward. After the fog dispersed the *Norge* found she was over the Baltic; the land sighted was mistaken, however, for Finnish territory, and the course was directed southward to reach the Gulf of Finland. As a matter of fact the *Norge* had lost her way, for she was already south of the Gulf. At 3.15 p.m. she observed a railway station and descended a hundred metres to find out its name; it proved to be Valk, a station on the frontier between Estonia and Latvia, about 120 miles south of the Gulf of Finland. From there the airship followed the railway line. A squadron of Soviet aeroplanes had ceaselessly patrolled the skies because of the failure of all efforts to establish wireless communication with the airship. By good fortune, and with the name of a station and subsequently a railway line to guide her—not by the help of wireless—the airship reached her port, Gatchina, a distance of 445 miles due east of Trosa, after a voyage of thirteen hours.

The failure of wireless communication was the more disappointing because of the specific reliance upon wireless for the navigation of this airship. It had been stated:[1]

> "Of particular interest is the direction finding system which will enable the navigators accurately

[1] The *Morning Post*, 20. 4. 1926, and the *Evening News*, 19. 4. 1926.

> to determine their position,[1] and course, despite the fact that the compasses will have negligible navigational value in the region close to the Pole."
>
> "No single part of the airship is of more vital importance to the success of the attempt or to the lives of the explorers than the wireless equipment."

As a matter of fact, though the most perfect instruments were fitted by the Marconi Company and special aerials surrounded the ship, the wireless again entirely failed after 87 degrees—about 1,500 miles from the landing place in Alaska. To the message sent out every five minutes over a period of time, "Airship *Norge* bound Nome. Please answer if anyone hears," no answer was received.

In the event, it was the sun and the magnetic compass which actually enabled Signor Nobile to make Point Barrow, coupled with air currents the direction of which favoured the airship. Had the current proved adverse, as Captain Nobile realised, they must have descended in the sea for lack of fuel.

While the impression is created that wireless telegraphy has solved the problem of the navigation of aircraft and communication for aerial pilots, it is quite obvious that wireless is unreliable,[2] and that its use is being pushed beyond its powers and, indeed, beyond its

[1] Dr. Eckener rightly foresaw the difficulty when he said: "It needs a complicated system of gauging to determine the position of the ship, even the wireless set is influenced by the conditions" of the Magnetic Pole. The difficulty of navigation is a greater obstacle than the extreme cold.

[2] The inherent unreliability and lack of secrecy in long-distance wireless communication prevents it from becoming a serious competitor with the great Cable Companies which continue to thrive and extend. If wireless telegraphy became entirely unsupported by public funds (under any cloak) its use would shrink to those purposes for which it is obviously suited, and in which it would prove a commercial possibility and a boon. It is apt to be overlooked that a quarter of a century has elapsed since wireless communication was established between this country and America. Long-distance wireless is by no means in its infancy.

true scope in many directions. It is noteworthy that Sir Alan Cobham, the most experienced and cautious pilot, carried no wireless during his great Australian flight, presumably considering that the extra fuel was of greater value than the wireless telegraphy installation its weight displaced.

Mr. B. N. Wallis (associated with Commander Burney in the construction of the R.100) has admitted that "with all the instruments that science and ingenuity can produce, the pilotage and navigation of an airship must necessarily present many complexities, for the conditions encountered on a long flight are variable and sometimes difficult to determine. Buoyancy, height, ground speed, and course made good are perhaps the most difficult and certainly the most important things a pilot wants to know."[1]

3. *A ship must have harbours and anchorages.*

Nature provides these for sea-going ships. For airships a sufficient number of mooring masts, landing grounds, and hangars must be provided at suitable places. The strength of the mooring masts for the new vessels with their enormous length (approximately 750 feet) and maximum diameter of 130 feet, is a matter of supreme importance, and has been the subject of expert investigation:[2] moreover, the masts must be provided with a mechanism for weighing loads.[3] "Experience showed a large airship could not be handled on the ground, at least not as a commercial proceeding, in strong winds." Without efficient mooring "the development of airships could not go on, and too much importance could not be attached

[1] The *Engineer*, 19. 2. 1926.

[2] *Parl. Debs.*, 21. 5. 1925.

[3] The Report of the Airworthiness of Airships Panel (R. and M. 970) says: "It is considered essential that all mooring masts should be fitted with a weighing mechanism with a view to assisting in maintaining as far as possible the trim of the ship, especially before casting off from its mooring."

to it."[1] Airship enthusiasts rightly insist that all airship ways must be generously supplied with mooring masts along their routes, including masts on the sea as a matter of necessity. The masts for the new airships take the form of steel towers 70 feet across at the base and 200 feet high, with stairs and a passenger lift in addition to long pipes and powerful pumps and ample storage room with adequate supplies for refuelling, regassing, and ballasting the moored airship.

A mooring mast is a station at which passengers and supplies can be taken aboard and minor repairs carried out if weather permits.[2] It is not a haven in a storm. An airship attached to a mast undergoes great strain in stormy weather; she pitches and rolls at her moorings; if the wind becomes too strong she must leave the mast and go off into the moving air.

Landing places and enormous hangars must be provided for the safety of these large and expensive craft, and much money and great energy have already been expended to this end. The enlarged hangar at Cardington in cubic area is the biggest building of its kind in the British Empire, if not in the world. "Waterloo Station could easily be put inside it, and there would still be plenty of room to spare, and Nelson's column would fail by 14 feet to reach the roof,"[3] for the height is 180 feet, the width 180 feet, and the total length 812 feet. The

[1] The late Mr. C. I. R. Campbell, Superintendent of Airship Design and Construction, in the *Aeronautical Journal*, February, 1921, p. 89.

[2] The airship *Norge I.* on arrival at Pulham was housed in the hangar and not attached to the mast. At Oslo she was moored, as no hangar was available, and though Commander Nobile declared that "his mooring gear on the *Norge* was stronger than the mooring gear on a rigid airship," he said "it would not be wise to keep the *Norge* at a mast during the variable weather of April. For that reason he would fly to Leningrad, where she could be put in a shed and wait indefinitely for a favourable opportunity to get to Spitzbergen where there was a shed of sorts." (*Flight*, 15th April, 1926.) At Oslo the *Norge* took in a fresh supply of gas and water ballast, petrol and provisions, and left twelve hours after arrival.

[3] The *Sunday Times*, 3. 10. 1926.

Cardington shed will, however, be much exceeded in size by the enormous shed in course of erection at Karachi, India, on which shed alone £172,000 of British taxpayers' money will be spent.

The Germans found that if an airship is housed in a fixed hangar, a cross wind of moderate velocity very effectively renders it weather-bound, and at great expense they constructed turn-table hangars; they held that adequate protection for airships at rest could only be secured in an enclosed space, and it is said that at one time they even thought of roofing in a small valley near Karlsruhe for the purpose.

Dr. Eckener still holds the same view—he states:

> "With regard to the difficulties of landing, I believe that we may expect great things in the future from the mooring mast, although I do not think that this is the perfect solution to the problem. I have long been inclined to the idea of placing large airship hangars where there is as little wind as possible and such localities can be found almost anywhere. The present demand is for flying fields as near to the big cities as possible, and though this may be necessary for aeroplanes which cover only short distances, it is not the case with air liners."[1]

On the Eastern Service the necessity of mooring masts, hangars, and landing grounds with the necessary gas-producing plants and repair shops and so forth, would indicate international complications.

The Americans came to the conclusion that an airship requires a mobile base at sea, and the *Patoka* was reconstructed for this purpose. This involved "the permanent fitting of a mooring mast, the installation of workshops, storage for helium gas, spare parts, gas bags, etc., and quarters for the officers and crew of the airship." The *Patoka*, intended as a refuelling and minor repair base for the *Shenandoah*, was also to be

[1] *Airways*, May, 1925, p. 292.

employed for towing the airship when occasions arose. It will not be overlooked that this question of towing may introduce very dangerous conditions of strain, since it is clear that the *moored* airship will undergo the full strain of the wind, in addition to the strain due to the speed and movement of the ship itself if the wind is a head wind. Should the wind be other than ahead, the towing ship herself is likely to become unmanageable.

4. *Ships must be capable of being readily handled for berthing, and must be safe when berthed.*

> "When an airship makes a landing, a crew of 200 or 300 men is needed to hold the ship down. The engines help to drive the ship down until it is within a certain distance of the ground, ropes are dropped, and the ground crew swarms on them like flies as soon as they are within reach. . . . In the fraction of a second that the ship is stationary—the infinitesimal pause between the time engines are driving it down and the buoyant gas starts to shoot it up again—dozens of men must grab the ropes and hang on. A second too early would knock them over, as if catching an express train, and an instant too late would skyrocket them heavenwards."[1]

Before attempting to land, the temperature of the ground must be ascertained as well as the direction and velocity of the wind. If there is much difference between the ground temperature and the air higher up, more care must be taken in bringing the ship down. She should be brought down very slowly; if the area below is colder extra gas may have to be valved, or alternatively if the air below is warmer, she may have to be lightened. A great airship is very fastidious as to the precise conditions for landing or mooring. Neither a flat calm nor

[1] *National Geographical Magazine*, January, 1925, p. 18.

a strong breeze suits her. She should have a steady breeze of between 10 to 15 m.p.h.[1] In a flat calm she must stop her engines or she will go ahead: if she stops her engines she may become uncontrollable due to differences of temperature as well as to total lack of aerodynamic stability.[2] If the breeze is strong she can stem the current with her engines, but when she stops her engines, as she must eventually do for housing, the ground party may have great difficulty in holding her and may themselves be lifted off the ground. *Once in her hangar the airship is safe.*

When the *Norge I.* (670,000 cubic feet capacity), flying from Rome to Oslo on her flight to the Pole, arrived over Pulham (11th April, 1926), there were drifting clouds with intervals of sunshine. This condition caused variations in temperature and consequently difficulties in landing.[3] After flying about for an hour the first real attempt was made to land, but excess buoyancy prevented the airship getting down low enough, and she sheered off and circled round again. After another forty minutes she was brought down again: she came in low towards the landing party and ropes were flung out. In the opinion of her navigator Commander Nobile, however, she was falling too fast, and ballast was discharged to prevent her striking the ground violently. The water drenched the people below, the ship shot up 1,000 feet in a few seconds, and some of the men of the landing party holding on to the ropes were lifted off the ground; "excited cries of

[1] *J. of the R. Ae. S.*, March, 1924, p. 206. An airship cannot safely be brought from her hangar in a wind of much over 15 m.p.h.

[2] When the air nearer the earth is colder than the air higher up instead of being warmer, as is general, the temperature conditions are *inverted*. "Under these conditions it is said to be possible for an airship to 'sit' on the top of an inversion with practically all engines stopped." (*J. of the R.U.S.I.*, November, 1925, p. 732.)

[3] On this afternoon at Pulham there was a steep temperature gradient—a strata of hot air near the ground; as the airship got into this warmer and lighter air she began to fall too rapidly. To avoid the possibility of bumping, ballast was thrown out and the airship, much lightened, shot up again.

'Jump!' were heard, the men flung themselves to the earth before they were lifted to a dangerous height," and the airship made another circuit. There were more unsuccessful attempts, and it began to seem likely that the airship would be unable to land until the weather conditions altered, but "at last Flight Lieut. Nixon seized the trailing rope, and by running furiously, got it to the winch." Gradually the airship was dragged down and walked quietly into her hangar.

Mooring to a mast is a simpler operation[1] so far as permissible speed is concerned, but in a flat calm the same conditions hold good. When secured to her mooring mast an airship is by no means at peace or necessarily safe. She is subjected to stresses and bending strains which, as the wind rises, may reach proportions impelling her for her own safety to cast off. Casting off was contemplated by the R.33; she was so buffeted by the storm at her mooring mast that the air was clearly the safer place against wind strain, but it involved the danger of being carried off beyond her power to return. In point of fact, the strain was so great that the R.33 eventually broke away, and though her engines were working well it took her nearly thirty hours to get back to her point of departure—with only a few hours' fuel left out of the "full supply" she had on board.[2]

But wind is only one source of trouble to a moored airship. When the R.34 was at Long Island in July, 1919, "the heat of the sun caused such an expansion of the gas that the airship became almost unmanageable. At times the men of the landing party were lifted off their feet, and at last an urgent call was sent to the neighbouring camp to turn out all available men to man the mooring ropes. Shortly after, the strain grew so

[1] "It was pointed out at the Air Ministry that the *Norge I.* has to be actually housed at Pulham—a much more delicate operation than that of being merely anchored to a mooring mast, and hence additional precautions in regard to weather conditions have to be taken." (*The Times*, 10. 4. 26.)

[2] Captain Scott in *Airways*, May, 1925, p. 270.

great that the mooring ring in the nose of the vessel tore out."[1]

"A relevant consideration is that designers will be called upon to cater for increasingly exacting conditions of mooring. The future commercial airship must, indeed, be expected to ride out at the mast in the heaviest weather, and it is by no means obvious that less demands would be made upon its structure on such occasions than during flight. An experimental programme could, therefore, hardly claim to be sufficiently representative, unless it embraced a tolerably conclusive investigation of the severest mooring-out conditions."[2]

5. *Any vehicle to be a practical and safe means of transport must be free to stop at any time without risk of disaster, and its stability at rest or in motion must not readily be disturbed.*

Great airships cannot remain stopped owing to lack of stability; aeroplanes because of the law of gravity. A sea-going vessel is of such a nature that she can remain on an even keel in the sea when at rest without anxiety as to the disposition of her loads, which may run into thousands of tons. An airship, on the other hand, has no stability at rest, and can only achieve stability by motion through the air. This induced stability (as opposed to inherent stability) is in practice so slight that great care must be taken in the disposition of freight, fuel, passengers, and so forth.

The loading and trim—the balance—of an airship at the start and during her whole voyage is one of the most important factors of safety, and a matter of delicate adjustment. The loading of the *Shenandoah*

[1] *The Times*, 8. 7. 1919.

[2] Mr. R. A. Frazer, B.A., B.Sc., A.F.R.Ae.S. (Nat. Physical Lab.) in *J. of the R. Ae. S.*, September, 1925, p. 406.

before her record trip in October, 1924, is thus described:[1]

> "No one who is not needed is on the 'bridge,' the forward navigating gondola, during these critical operations. The others are at their designated 'landing stations' or being shifted back and forth along the keel, human plummets, to keep the long tube (the airship) balanced." Water ballast is released fore and aft, for equilibrium must be established; "it is dropped in spurts of hundreds of pounds. In an emergency, when the ship is heavy, even a gasolene tank may go. Men are shifted again to keep the balance. One man walking the length of the ship when the engines are not running changes her level 3 degrees, so carefully is she balanced. To balance the ship before getting away 'A man from 105 and a man from 60, into the tail,' is shouted down the long keel tunnel. The vibration of the motors drowns the thud of their feet as they race uphill along the narrow runway" (the Cat's Walk, 9 inches wide along the whole length of the ship, 680 feet).

Some form of weighing device for vertical loads in the head of the mooring mast or in the bow of the airship is considered essential by the Airworthiness of Airships Panel; and as "it is possible for a pilot to maintain trim by an unsuitable arrangement of ballast, which might easily lead to very serious stresses, a schedule of the permissible distribution of disposable weights should be drawn up, approved, and rigidly enforced."[2] In an airship "the disposable and movable loads, such as the fuel, ballast, passengers and crew, constitute such a large proportion of the total weight of the airship, that improper distribution of these loads may easily bring about

[1] *National Geographical Magazine,* January, 1925, pp. 7 and 13.
[2] R. and M. 970.

dangerously large stresses" upon the structure of the ship.[1]

Moreover, in an airship, constant care is essential for the maintenance of trim, which is continually changing owing to the expenditure of fuel and the movements of passengers or crew.[2] On the voyage of the R.34 to America it was found that—

> "During meal-times ship is inclined to get an angle slightly down by the bow, owing to officers' and crew's dining quarters being situated too far forward . . . necessary to send some of the crew aft to correct trim."

If a gas-bag becomes deflated[3] a corresponding weight of fuel, or ballast, or what not, must be taken from the region of the loss of lift and dropped to maintain buoyancy and approximate trim. Correct trim must be obtained by moving weights fore and aft, but only according to schedule, to avoid dangerous stresses on the structure itself. Some adjacent cells may also have to be partly deflated so as to equalise the pressures on the gas-bag frames, and this additional loss of gas will necessitate further jettisoning of suitable disposable loads and further correction for trim.

If a serious breakdown occurs in an airship's engines she must, if she can, make for the nearest or most convenient mooring mast or hangar. With her engines stopped, as has already been pointed out, an airship's longitudinal stability is negligible. An analogy is to be found in a submarine[4] submerged with her motors

[1] *J. of the R. Ae. S.*, June, 1924.

[2] *Vide* p. 267, para. 4.

[3] A deflated cell can cause severe stresses, and great care must be exercised in operating under such conditions.

[4] The airship moves in one medium only, the air; a submarine submerged moves in one only, water. The analogy between the instability of a submarine submerged with her motors stopped, and an airship afloat with her engines stopped, is almost exact.

stopped. Under these circumstances, unless she is perfectly trimmed and remains so,[1] the submarine must choose to rest either on the bottom, or come to, and rest on, the surface. With all her engines stopped an airship is at the mercy of the element she is in. Drifting along in the horizontal current and subject to such vertical currents as may be present, she will soon begin to sink by the bow or stern according to whether she is heavy forward or aft. There is for her no surface to rise to and no bottom to rest on without inevitable disaster to the ship, if not to the passengers, and on the proposed Eastern Service the nearest mooring mast is to be erected at Ismailia, nearly 2,200 miles away.

6. *The useful load carried—cargo, mails, and passengers—must be in reasonable proportion to the effort and expense of such transport; in other words, commercially (and militarily) the end must justify the means.*

In airship transport the effort is enormous—the whole result in useful load negligible.

The total lifting power of the new 'Burney airship,' R.100, of 5,000,000 cubic feet capacity, is (if filled with hydrogen gas) 151·7 tons at sea level, with standard purity of gas and under standard atmospheric conditions;[2] in the tropics there is a reduction in lifting power which may be as much as 7 per cent. (or 10 tons in a 5,000,000 cubic feet vessel). The lift for practical purposes of this airship (or R.101) may be taken as 150 tons in this country. From this gross lift of the hydrogen gas must first be taken the weight of the structure and machinery, fittings and fixtures, which " is not to exceed" and most

[1] This condition can only obtain for a few minutes at most.

[2] Lifting power of hydrogen in airships is always computed on the basis of 68 lbs. per 1,000 cubic feet.

certainly will approximate 90 tons,[1] leaving a balance of 60 tons for disposal. The weight of the necessary ballast (15 tons[2]) and of the fuel and lubricating oil must be deducted, and an allowance made for the crew, before the useful weight left over for freight, or for passengers and their impedimenta, can be determined. The amount of kerosene and oil required will depend on the length of the voyage; endurance and safety depend upon the amount of fuel, lubricating oil, and stores on board, and the greater the endurance and safety aimed at, the more fuel and oil must be taken. For such a giant vessel on the proposed route from England to Ismailia, the weight of fuel and oil could not be less than 30 tons.[3] A crew of fifty,[4] with their necessities,[5] would add over 6½ tons, leaving for this great passenger airship—a vessel as large as the *Mauretania*—an approximate useful lift, that is, a paying load, of 8½ tons only at sea level in this country.

The Secretary of State for Air, Sir Samuel Hoare, has stated[6] that the new airships are designed to carry 100 passengers, 20 tons of freight, and a crew of fifty. Allowing 300 lbs. only for each of the crew and 400 lbs. for each passenger, the distribution of the load on the

[1] *J. of the R.U.S.I.*, February, 1925. Later details of these airships indicate increased amenities for comfort, inevitably entailing greater weight of fittings and fixtures, if not also of the structure.

[2] 10 per cent. of gross lift; *vide* p. 38, para. 2.

[3] The time to Egypt by airship is reckoned as 2½ days (60 hours). Sir Trevor Dawson stated at Sheffield, after the contract had been secured by the Airship Guarantee Company, that 7 units of 550 h.p. were to be used, at little over ½ ton of fuel per hour. (*The Times*, 7. 11. 1924.)

[4] The R.34 carried a crew of thirty and the *Shenandoah* carried forty. With the enormous increase in gas-bag capacity there would be a considerable increase in the number of riggers required, and with a passenger list of 100 in addition to the navigational crew, a complete kitchen staff, stewards and stewardesses, etc., would be essential.

[5] Weight of crew, with clothing, rations, water, and bedding, is calculated as 300 lbs. per man. The weight of passengers, with luggage, food, water, bedding, etc., is taken as 400 lbs. per head.

[6] *The Times*, 12. 6. 1926.

'Burney ship' can be shown, and the total weight estimated with considerable accuracy:

	Tons.
Weight of duralumin structure (some 760 feet long and 130 feet wide), engines (giving 3,850 h.p.), instruments, directional wireless, promenade decks, two and four berth cabins and other essential accommodation, dining-room to seat fifty persons, with furniture, fittings, and all dining accessories, smoking-room, lounge, kitchen, etc.	90
Ballast	15
Fuel and oil	30
Crew of fifty (300 lbs. per man)	6½
Passengers, 100 at 400 lbs. each	16½
Freight	20
	178

giving an excess weight of 28 tons, which could not be lifted off the ground since the gross lift is 150 tons.

This excess weight over lift must be eliminated and the weights of various items perforce reduced. If the structure is to retain any appreciable *factor of safety*, and if the accommodation according to schedule is provided, no reduction on 90 tons seems to be permissible: the regulation ballast is fixed; the calculation of fuel and oil includes no reserve. These make a total of 135 tons, leaving only 15 tons for crew and useful load. The crew of fifty at 200 lbs. each inclusive would absorb 4½ tons, leaving 10½ tons only for passengers and freight in this great air liner. A passenger list of 100, allowing only 235 lbs. each, would balance this weight and no freight could be carried. In the Cairo-Karachi Air Service 225 lbs. per passenger is allowed, inclusive of baggage (165 lbs. personal weight and 60 lbs. baggage), but few meals if any will be served—certainly no five to six course dinners—and no bedding is required. On a non-stop airship flight these extras and many more will be needed. At 200 lbs. per head for the crew and 235 lbs. per head for the passengers, there would be little food and scanty comfort.

The designers of the Air Ministry ship, R.101, seem even more ambitious than those of the R.100, for in addition it is proposed to provide an electric lift and shower baths, also facilities for dancing and the playing of games; from the models shown at Cardington to the Colonial Premiers, the actual accommodation could quite fairly be "compared with the spaciousness and comfort of the public rooms of a liner." This ship is to have a range of 4,000 miles, and must be able to fly at 70 m.p.h. at an altitude of 5,000 feet. The weight of this huge structure of stainless steel, 730 feet long, with engines of Diesel type, instruments, fittings and fixtures, is intended to be 80 tons only. This *stainless steel* ship is thus estimated to weigh 10 tons less than the maximum weight allowed for the *duralumin* vessel of the same cubic capacity. It is proposed to install five engines of 600 h.p. of Diesel or semi-Diesel type, and experimental work is still being carried on by a firm of well-known engineers. The difficulty in this direction is the reduction of weight. Petrol engines of the same horse-power would weigh over 2½ tons—Diesel engines incomparably more.[1] The distribution of weight in this Air Ministry vessel is therefore as follows:

	Tons.
Weight of structure of stainless steel, engines, etc., given as	80
Ballast	15
Fuel and lubricating oil for 4,000 miles, say	40
	135

leaving 15 tons only for crew and passengers (inclusive of bedding and luggage, food and water), for a non-stop journey of 4,000 miles in this "Dirigible de luxe." If however, as the Air Ministry state, the average flying height is intended to be 3,000 feet, such a weight must not be embarked, for the loss of lift in such a vessel approximates 14 tons at this height.

[1] *Vide* p. 117, para. 3, and p. 118, note 2.

In view of the immutable laws governing the lift of gases and the calculable reduction of that lift at varying heights, it is almost incredible that in an article on airships intended to be informative, one who was once our Secretary of State for Air writes:[1]

> "They will take a pay load as heavy as that of an ordinary train across lofty mountain ranges."

The actual weight carried by the *Shenandoah* on her record voyage over the Rockies is exceedingly instructive. The total lift of this airship (2,115,174 cubic feet) would have been 65 tons if filled with hydrogen, but filled with helium it was only 60 tons. As soon as an airship rises the gas expands due to diminished pressure in the atmosphere, and if the bags are quite full before leaving, gas must be valved to avoid undue internal pressure on the bags. Helium is very expensive, even in America, where it costs over £11 per 1,000 cubic feet. To avoid valving valuable gas before a height of about 4,500 feet was attained, the bags of the *Shenandoah* were not filled more than 85 per cent.[2] This further reduced the gross lift to 49 tons. The dead weight of the ship when dry, without petrol or water ballast, was 36½ tons, and she took with her fuel, oil, and water amounting to over 9 tons, leaving little more than 3 tons for the crew of forty and their necessities. She was in fact too heavy, and to help the lift and enable her to get off with her load the *Shenandoah* timed her departure when the sun had warmed the gas in her gas-bags and before the earth began to radiate the heat of the sun, for with each degree that the temperature of the bags rose above the tempera-

[1] Lord Thomson in *Airways*, January, 1927.

[2] Even when only 85 per cent. full, the helium in the *Shenandoah* was valued at nearly £21,000; 5,000 cubic feet of gas escaped through the valves of the *Shenandoah* for every 100 feet above pressure height (about 4,500 feet); she rose on this voyage 7,300 feet. (*National Geographical Magazine*, p. 17.)

ture of the surrounding air, the ship lifted another 300 lbs. Before the crew went aboard—

> "Each one, as he came to the top of the mast, had asked permission from the 'bridge' before he had stepped on to the little gangway. At times the ship was buoyant enough to take him, others had been ordered to 'stand by.' In a few minutes the ship would grow lighter, and the order would come for one more to step aboard. That meant only minutes for them, for it was certain that they were going. It meant more for the passenger. Weight in fuel took precedence over passenger cargo. If enough 'lift' remained after the required amount of gasolene was aboard, the passenger was going; otherwise, no passenger."[1]

The personal luggage of the one civilian passenger was limited to 6 lbs. The airship carried no freight.

On her final trip (September, 1925) the aggregate load of the *Shenandoah* was made up as follows:

Weight of airship, engines and instruments[2]	36·61	Tons
,, of fuel	7·42	,,
,, of oil	0·38	,,
,, of water ballast	3·06	,,
,, of reserve water	0·42	,,
	47·89	Tons
A crew of forty-three was carried. Less than 282 lbs. per head must have been allowed (to include clothing, supplies, bedding, etc.), for this additional weight would amount to	5·41	,,
Total weight	53·30	Tons

The total lift with helium gas[3] was 53·3 tons. No passengers or freight were carried—no surplus lift remained.

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[1] *National Geographical Magazine*, January, 1925, p. 2.

[2] It will be noted that the fixed load (structure, engines and instruments) absorbed two-thirds of the total lift—only one-third was left for disposable load.

[3] The gas-bags on this occasion were filled 91 per cent. ("Technical Aspects of the Loss of the *Shenandoah*," p. 493.)

The Airworthiness of Airships Panel has recommended that the regulations relating to the ballasting arrangements in airships include (*a*) that the storage capacity be of such a size that the total weight of ballast that can be carried is not less than 10 per cent. of the gross lift of the gas in the airship when full at sea level; and (*b*) that if any portion of this storage capacity contains petrol, such petrol shall not be regarded as fuel in connection with estimation of performance or as landing ballast. Moreover, the Committee says (*c*) that part of this storage, not less than 5 per cent. of the gross lift of the gas in the airship, must be of the emergency type—*i.e.*, capable of rapid discharge, and operated from the main control position in the airship; and it further says (*d*) that 30 per cent. of the fuel tanks be fitted so that they can be dropped from the airship in the case of emergency.

The loading of an airship is a matter of concern and fine adjustment, and every item of weight must be carefully considered. On the voyage of the R.34 to America, each member of the ship's complement was provided with two complete suits of silk underclothing and special woollen gear to wear over the silk. The outside garment consisted of light wind-proof material, into which the parachute harness was fitted and sewn.[1] Just before starting—

> "It had been decided that one of the members of the crew (A.C.2 W. W. Ballantyne) must be left behind, the numbers being limited of necessity to thirty." Twelve hours later Ballantyne "emerged from his hiding-place . . . it is bad from a disciplinary point of view, to say nothing of risking the success of the flight. Without his weight we could have carried 200 lbs. more petrol. Had there been

[1] *The Times*, 1. 7. 1919.

land beneath us instead of ocean we would put him off at once in a parachute; but as we are now well out in the Atlantic, there is nothing for it but to take him across."[1]

There are other factors affecting lift which must be taken into consideration. A heavy dew on the extensive surface of an airship, a shower of rain,[2] a light fall of snow, and the humidity of the atmosphere, affect lift materially, and in consequence the amount of fuel or useful load which can be taken.

When the crew of the Z.R.3 went on board (for her flight to the U.S.A., October, 1924), the airship was unable to ascend owing to the fall in temperature and misty conditions; though two petrol tanks were emptied, she did not rise and her departure was postponed.[3]

On the voyage of the R.34 the ship got very heavy at one time due to the change of temperature, and was down 12 degrees by stern. It became necessary to lighten her, and rather than drop petrol (as ballast), all her engines were set running to use up the fuel; and if an airship finds it necessary for any reason to rise high during her voyage, she must be prepared to sacrifice some petrol, or freight, when other ballast has gone, for "men, engines, and a certain amount of fuel and oil are not classed as 'disposable' ballast."[4] When the U.S. Airship *Shenandoah* crossed the Rockies, though her engines were going full speed and her elevators were at the maximum tilt of 13 degrees, giving maximum aerodynamic lift, she had to throw overboard 1,400 lbs. of petrol as well as all water ballast, in order to gain

[1] "Log of H.M.A. R.34."

[2] The heaviness caused in R.33 by rain alone may be as much as 1·5 tons. (*J. of the R. Ae. S.*, March, 1924.) For the *Shenandoah* the amount is given as 2-3 tons. ("Hearings of the Morrow Commission," vol. iv., p. 1463.)

[3] *The Times*, 13. 10. 1924.

[4] *National Geographical Magazine*, January, 1925, p. 13.

sufficient buoyancy to enable her to reach an altitude of 7,300 feet.

Dr. Eckener, who has been engaged in building airships for about twenty-five years, and is likely to take a most favourable view of airships and their carrying capacity, speaking of a proposed American Service, states: "Construction has so far advanced that airships can be built to-day" to have 15 tons of paying load. "Calculated on the basis of a service employing three large airships and an average of 100 trips per year—fifty each way—each single voyage would cost about £10,000";[1] in other words, the operational cost alone would be at the rate of nearly £700 per ton, including in this tonnage, passengers, freight, and mails. If the concern were established on a commercial basis, to pay interest on capital, the revenue according to Dr. Eckener, should be £15,850 per single voyage. Reckoning for full load, the rate charged would thus be £1,200 per ton, or 8d. per ounce. The ordinary shipping rate for the transport of goods to America is under £5 per ton.

7. *Every modern means of transport must be safe, reasonably comfortable, and capable of keeping to a time-table.*

In ships, speed has no bearing on safety; while in other legitimate means of transport, speed and safety are generally opposed. In airship flights, speed is one of the governing factors of safety, owing to the translatory nature of the medium. Higher speed (which means bigger engines and more fuel) can only be obtained at the cost of lift taken from the strength of the ship or from useful load; but the strength of the ship must be increased to meet the much greater aerodynamic strains imposed by the greater speed,[2] and therefore useful load

[1] *Airways*, May, 1925, p. 278.

[2] The aerodynamic forces are proportional to the *square* of the speed.

must be sacrificed. All airship flights have been begun in favourable or promising weather with the exception of forced flights due to breakaways. Their experiences have shown that airships are far from reliable, and are exposed to danger from structural failure, from lack of stability, from lack of lift, and striking high ground or obstructions, from fire, from thunderstorms, from vertical upheavals, and bursting of gas-bags, from exhaustion of fuel, from uncertainty of landing and lack of havens. Against all these terrible and great dangers slender security is provided in the provision of parachutes, which would be supplied to passengers and crew as lifebelts are against shipwreck. In view of the limited lift and the precedence perforce given to fuel, everything must give way to lightness in fitting and fixtures; furnishing and appointments must be restricted, making comfort difficult and indeed impossible to attain.[1] The start of a voyage should be made before sunrise and preferably in the coolest part of the night if superheating is to be avoided,[2] and the airship must be navigated for safety rather than for comfort. Though clouds are cold and damp, it may be necessary to navigate purposely through them in order to keep the temperature of the gas-bags down and to avoid losing gas. The bumpiness at the low levels at the beginning of a voyage must be tolerated until petrol is consumed and buoyancy thereby increased, for gas should not be readily given up while the ship is heavy. In all modern transport, regularity and relia-

[1] On the *Norge I.*, as fitted out for the Polar flight, there was little or no accommodation for the crew. There were no bunks and few seats. On the voyage from Rome to Pulham there were only four seats for the twenty-one persons on board, and they were all obliged to stand up practically the whole of the time—thirty or more hours. The food was all preserved, and the only hot drinks were those taken aboard in thermos flasks.

[2] To save helium, which is very expensive, the gas-bags of the American airships are not filled at the start and the lift is much reduced; advantage is taken of superheat to make up some of this lost lift.

bility are essential desiderata—trains start to the minute, ships to the hour—if an airship is to wait for a favourable wind or settled conditions it may start at any time or not at all, and no adherence to a time-table would be possible or indeed expected. To return in means of transport to material dependence upon the wind or observance of the weather is retrogression not progress.

Preparatory to the flight of the *Norge I.* from Rome to Pulham it was stated:

> "A Norwegian scientist has been attached to the Air Ministry in London for some time, studying the meteorological conditions over the route, and daily bulletins are now being sent to Rome of the weather conditions between England and Italy. It is expected that as soon as these are favourable the airship will start for Great Britain."[1]

It was arranged that the airship should leave about Good Friday (2nd April), but the departure was postponed owing to bad weather. The airship was again prepared to leave Rome at about 9 a.m. on Thursday (8th April), but shortly before that hour a strong head wind sprang up and the airship could not start; moreover it was stated:

> "The time for the departure of the airship has also been rendered the more uncertain by reason of the fact that the weather conditions over Pulham in Norfolk, where the *Norge I.* will be temporarily housed, are becoming less favourable."[2]

Commander Nobile had been waiting in Rome for a start at the earliest opportunity, and at last the departure was made at 9.30 a.m. Saturday, 10th April, when the weather became propitious.

Should an airship leaving for a 2,000-mile voyage encounter a directly opposing and steady current of 30 m.p.h. for thirty-six hours only, she would be set

[1] *The Times*, 7. 4. 1926. [2] *Ibid.*, 10. 4. 1926.

back in her course 1,080 miles. Assuming a flat calm for the remainder of the voyage she would have flown 3,080 miles in a calm, and not as is generally assumed, a 2,000-mile journey against a light head wind. On the assumption of a mean speed of 50 m.p.h. the time for the voyage would be sixty-one and a half hours instead of a calculated or scheduled time of forty hours. Should the ship not keep to her direct route but make a detour to escape from the unfavourable current, she might increase her mileage to an even greater extent, for with a comparatively low wind the depression may be very extensive.[1] It is self-evident that as the airship is liable to constantly fluctuating currents which may be even more rapid than her own speed, it is impossible to keep time. Should the current happen to be flowing in the same direction as that in which the airship wishes to go, the airship might arrive long before she was expected. On the other hand, if the same rate of current commenced to flow in an unfavourable direction the airship might not be able, for lack of fuel, to reach her port or return to her point of departure, and no mooring mast or ready hangar is likely to be anywhere within her reach.

No transport service can be regular and dependable if an all-important factor is variable, and may at any moment become adverse and continue so for an indefinite period. "An airship Commander must never be bound down by direct orders," he "must never be told how to go to a place or *when to get to a place.*" . . . "Weather conditions make changes necessary, and other conditions, wind direction, etc., also make changes necessary."[2]

[1] *Vide* p. 46. Such a wind "may blow over a comparatively large area and for long periods." (Major Scott in *Aeronautical Journal*, February, 1921, p. 56.)

[2] "Hearings," p. 649. It was stated (*The Times*, 23. 4. 26) that "Signor Nobile and Lieutenant Larsen have decided that the airship *Norge* shall leave for Spitzbergen after the 24th April, and not later than the 27th": but days passed, and only on the 5th of May was the weather sufficiently favourable for the airship to leave her hangar at Gatchina near Leningrad for her next station, Spitzbergen.

Though the sky is open, an airship can rarely set her course on the direct air route—as the crow flies—to her destination. Apart from the changes in direction necessitated by unfavourable air currents (adverse winds) she must make detours to avoid high mountains, wind-swept valleys, thundery regions, and other dangers.

The *Norge I.* (after a delay of eight days) started from Rome in weather favourable for her voyage to Pulham, but she could not take the direct air route (about 900 miles N.W. by N.), for it led over the Alps. She might have taken the next route up the Rhône Valley, but that is a region of comparatively frequent thunderstorms and these are inimical to an airship and must be avoided if possible; therefore, starting off in a favouring current (a south-easterly wind) she set her course W. by N. to Toulouse, and then more northerly to Rochefort on the Bay of Biscay, attaining, with an average speed over the whole distance of 53 land m.p.h., a maximum of 70 land m.p.h. The airship had then to change her course N. by E. for Pulham. Her speed (the land miles made good) immediately dropped, though her engine speed remained the same, and for the next eight hours her progress was on the average only 17 to 18 m.p.h. At times the airship made no progress, being carried as quickly in one direction by the current as her engines drove her in an opposite direction by their steady working. Fortunately the wind died away, enabling the airship to finish the last 250 miles at the rate of 45 m.p.h., and to arrive at Pulham after a voyage of thirty hours with eight hours' fuel left in her tanks.

When an airship leaves her port, anything may happen. She may arrive at her destination at any time, or never, depending upon the weather conditions, the speed and direction of the air current, and the amount of fuel on board. If the air current is favourable the airship will rise if she can and take advantage of the swifter and generally smoother current at the higher altitude, but this may not be possible; for at the start of

the voyage an airship is heavy with much unexpended fuel:

> ". . . the wind is stronger in our favour the higher we go up, but in spite of that Scott decides to keep at a 3,000-feet level to avoid the necessity of losing gas through expansion which to-day is precious. To-morrow he can afford to go higher, as the airship will be so much lighter on account of having burnt another twenty-four hours' petrol."[1]

On the other hand if the current is adverse the airship will have to work all her engines and expend fuel to make much way in a very moderate current, or any way in a strong one.[2] Under these conditions an airship will keep as low as she can, because the higher she rises the swifter is the current carrying her off her course and impeding her progress towards her port. She might try to go round the depression by altering her course, but an airship cannot afford to go far out of her way because of the drain on her fuel supply. The following gives an experience of the R.34 on her outward journey:

> "Two aft engines resting. Air speed 36 knots (41 m.p.h.). Making good nothing. Strong head wind against us and low cloud. Height 1,000 feet. Too depressing! We are up against a wind barrage . . . if only we had sufficient petrol we would now change course to the westward and so get round behind this."

It has been claimed that Buys Ballot's law is of great value in airship navigation; that by the application of this law—discovering the position of the ship in the storm area and circumnavigating the depression—the worst

[1] "The Voyage of the R.34," *The Times*, 14. 7. 1919.

[2] The R.34 ran into a cyclone on her voyage 600 miles out: it forced her to use all her engines at full speed and made a severe drain upon her petrol supplies. For thirty hours she was in this adverse current. (*The Times*, 7. 7. 1919.)

winds can be avoided: but this involves a change ot course and expenditure of precious fuel, the amount of which will depend upon the speed of the airship, the rate and direction of the wind, the size of the depression, and the direction in which the depression itself is moving. It will be realised that while crossing the current, placing herself broadside to it, in her endeavour to reach the outskirts of the depression (which may even be 1,000 miles across), the airship experiences the full drift of the current while she is crossing; the distance of this drift in miles being the speed of the air current multiplied by the hours taken in crossing the depression, and this distance must be added to the actual distance between the place of departure and the place it is desired to reach. *In fact, for aircraft, the distance between two places is not the geographical distance, but the distance determined by the air currents prevailing at the time.*

In temperate latitudes an average deep depression is 700 miles across, and gales also occur with no defined area of depression, the whole atmosphere over the sea, ocean, or continent being in motion.[1] In tropical regions storms in general are greater in intensity, while the area of the depression tends to be less. But it seems to be overlooked that the application of Buys Ballot's law is dependent first and foremost upon the knowledge that a depression in fact exists, and then upon the accurate knowledge of the direction of the wind at any moment. It has been shown—at some pains—that an airship has no means within herself of knowing the existence of a depression, for her barometer is little guide, nor has she accurate knowledge of the direction and force of the wind—the current in which and with which she is herself moving; and if no directional wireless station (or vessel,

[1] Sir Napier Shaw, F.R.S., speaks of "a vast cyclonic circulation some 2,000 miles across, covering the North Atlantic from the north of Greenland to the Azores and from Nova Scotia to the English Channel. It provides an air current fully 1,000 miles wide." (*The Times*, 6. 2. 1926.)

if the airship is over the sea) has transmitted to the airship the weather conditions, the existence of a depression and the direction in which it is moving will be unknown to her.

It will be appreciated from the foregoing that the wind—ignored entirely in railway travel, a very small factor only in steamship navigation—assumes an importance infinitely great and vital in all air navigation, for *it dominates aircraft to the full extent of its own speed and direction, because to airships afloat it is a current, as it is also to aeroplanes.*

This fundamental fact, with all the disabilities it implies, governs the whole of aircraft operation for all time.

" *Facts are chiels that wanna ding.*"—BURNS.

CHAPTER III

THUNDERSTORMS AND AIRCRAFT NAVIGATION

THE number of thunderstorms in the year has been calculated at 16,000,000, or 44,000 daily. "At certain tropical stations where in rainy seasons storms are severe at certain times of the day, distant thunder is so common that it simply does not occur to the observer to enter it in his register. He may not in fact consciously be aware of its occurrence. Java is the most thundery region of the earth, and this should be taken into account in planning air routes to Australia."[1]

Dr. Eckener in his lecture to the Royal Aeronautical Society on the 27th March, 1925, said:

> ". . . there was one condition which must be given if lightning was to do no harm—the ship must not let out any gas either through the valves or through deficient gas cells, for otherwise the electric spark might strike an explosive mixture. As a matter of fact . . . they *must* and *would* come to a combination of hydrogen and helium. Then they would emit hydrogen only when it was safe, and when they could save thereby the expensive helium."[2]

In view of the danger from hydrogen there is a very natural anxiety on the part of the public, and questions in regard to the matter have been addressed to the Secretary of State for Air. His replies make it clear that hydrogen gas without any helium will be used on the experimental flights to Egypt and India.

Hydrogen costs 10s. per 1,000 cubic feet to produce at Cardington and 30s. per 1,000 cubic feet at Pulham;[3] in Egypt and India it is likely to exceed the higher figure. Helium is not produced in this country: some

[1] "The Distribution of Thunderstorms over the Globe," C. E. F. Brooks, M.Sc.: Stationery Office.

[2] *The Times*, 28. 3. 1925.

[3] *Parl. Debs.*, 9. 7. 1925.

years ago when the Admiralty carried out experiments, it worked out at 6d. per cubic foot, or £25 per 1,000 cubic feet; in Germany the price is given as £17 14s. In America helium is obtained from natural gas at a cost, it is stated, of £11 7s. 6d.[1] for the same quantity, but its export is prohibited.

Helium alone has been used for the navigation of the two U.S.A. Airships *Shenandoah* and *Los Angeles*, and it was stated that the supply was not sufficient to inflate both airships simultaneously. When the *Shenandoah* made her voyage in October, 1924, gas wastage[2] must have been considerable, for she was obliged to take in, on her return journey after crossing the Rockies, no less than 180,000 cubic feet of helium. On the arrival of the Z.R.3 (*Los Angeles*) from Germany in October, 1924, "the naval officers at Lakehurst were concerned to get the hydrogen out of her gas-bag without delay in order to substitute the non-explosive helium gas."[3] Helium is heavier than hydrogen and has about 7 per cent. less lifting power.

It is perhaps not without significance that whereas Dr. Eckener in his lecture in March, 1925, called special attention to the danger to airships from lightning when hydrogen only is used, he makes light of it in a special

[1] If sufficient natural gas is available it can be extracted, with new and improved methods, at a cost of £5 per 1,000 cubic feet. (*Engineering*, 19. 2. 1926, p. 221.)

[2] Gas is automatically valved during an airship voyage when the pressure of the gas in the bags, due to height or rise in temperature and superheating, is greater than that of the surrounding air. It may also be discharged (for navigational purposes) to compensate when necessary for the increased buoyancy as fuel is consumed or on landing. There is also a certain waste of gas due to leakage, and a constant diffusion, and consequently a deterioration of lift, owing to the fact that some of the hydrogen is gradually being replaced by air. "Even if the lost hydrogen be restored, the percentage admixture of air is always increasing. Consequently the gas must periodically be replaced *in toto* to maintain the lift." ("Commercial Airships," H. B. Pratt, p. 131.)

[3] *The Times*, 14. 10. 1924.

article written a few months later.[1] He dismisses the danger of lightning in the following words:

> "The question as to whether an airship is in danger from lightning during a thunderstorm is perhaps the one which is responsible for most of the scepticism about a proposed regular airship service. It is quite true that when an airship is travelling through squally weather it is very probable that electric sparks will strike the ship, as the long metallic framework presents an excellent conductor to lightning. But I have always been convinced, and am to-day, that this lightning is by no means dangerous, as it is caught by the metallic girders and finds its exit somewhere around the stern of the ship or by way of the antennæ."

It is true that a flash of lightning might reach the ship as a spark, might pass along the girders (without a spark if there were no unevenness or break), and leave the airship as a spark, the lightning taking the airship, "an excellent conductor," in its stride, so to speak.[2] It might not be dangerous if no hydrogen were escaping by leakage or being valved, or if no petrol vapour or inflammable stuff were near any part where a spark might occur. Nothing untoward might happen, however uncomfortable or terrifying the experience might be.

But the surface of the airship may become charged in an electrically disturbed area, or by flying through dry snow or through a sandstorm.[3] "Friction of air on the cover, and of escaping gas on the valves, causes sparking which in many cases has proved fatal. Danger

[1] *Airways* (Special Airship number), May, 1925.

[2] In one German airship caught in a thunderstorm the wireless weights were burnt off; in another the bow was struck and bow girders were fused together. (*Aeronautical Journal,* February, 1921, p. 92.)

[3] Flying through dry snow the ship is apt to become highly charged, so that it is always advisable to pull up aerials under these conditions. (*J. of the R. Ae. S.*, March, 1924.)

to the airship is principally in the discharges which occur when any part of the airship touches the earth, or when the airship flies into a cloud strata at different potential. Efficient bonding of all metal parts is desirable in order to prevent local discharges, and it is now generally accepted that it would be of advantage to have the whole surface of the airship a continuous conductor. The majority of fabrics in general use are very poor in this respect."[1]

The Log of the R.34 records unpleasant and indeed alarming experiences due to thunderstorms:

> *2nd July*, 1919.—"Passing through this thick cloud the ship has collected a considerable quantity of electricity, with the result the wireless operators report unpleasant electric shocks. Airship is probably negative, and the cloud positive, causing slight discharge from the cloud to the ship."
>
> *5th July*, 1919, 1.30 *p.m.*—"We begin to notice distinct evidence of electrical disturbances."
>
> 2 *p.m.*—"Though the sky has not got much worse, atmospherics have become very bad. Scott turns left-handed off his course towards Nova Scotia to avoid it, but storm also extends eastwards. He puts on all engines to try and get away from it, and orders are given to stow away all loose valuables."
>
> 2 *p.m.*[2] —"Atmospherics now terrific." Wireless Operator received "shock through headphones, and drew sparks off aerial."
>
> 2.45 *p.m.*—"Caught in violent squall on extreme outskirts of the storm. Ship very badly thrown about, rising 700 feet in one bump. Storm almost tropical in its violence. Our first warning was when the helmsman pointed to the compass card, which was spinning round like a top. Harris thinks that had we been caught in the centre of this storm, the bumps would have been so severe that the ship

[1] *J. of the R. Ae. S.*, March, 1924, p. 211.
[2] From Wireless Log.

might have been damaged in the air. It is difficult to estimate the size of these storms, but as the squalls which hit the ship were about 50 miles from the storm itself, the area covered must have been many thousands of square miles. During the summer months these storms are frequent on this coast, and are a grave danger to all aircraft."

6 *p.m.*—"Dodging another colossal thunderstorm. Had to haul in W.T. aerials, as attempts to use wireless resulted in 2-inch sparks owing to highly charged atmosphere. Ship again badly thrown about—very unusual bumps."

9.30 *p.m.*—"Another thunderstorm; again we have to change our course to avoid it, and every gallon of petrol we have is worth its weight in gold. It almost breaks our hearts to have to lengthen the distance to get clear of these storms."[1]

"Violent . . . bumps. Ship is first lifted 400 feet and then dropped 500 feet—measured on our aneroid. Standing more out to sea, and running on all five engines to get further from this locality, a heartbreaking manœuvre, as it will reduce still further our depleted petrol supply. Thunderstorms by day are bad enough, but at night they are particularly unpleasant, and the ship vibrates from bow to stern. We wear our parachutes, and lifebelts are all ready."

In the words of one of the crew of the R.34: "The thunderstorms were awful. First she sat on her tail, then shot up hundreds of feet and fell back again almost into the water."[2]

The "bumps" were experienced in spite of the fact "that the R.34 deviated a distance of approximately 50 miles to skirt the thunderstorm"[3] when "every gallon of petrol was worth its weight in gold."

[1] *The Times*, 7. 7. 1919. [2] *Ibid.*, 8. 7. 1919.

[3] Sir Samuel Hoare's reply to Commander Bellairs, *Parl. Debs.*, 7. 8. 1925.

The Report of the Airworthiness of Airships Panel may well be quoted here:

> "The evidence on the subject of the effect of electrical discharges on lighter-than-air craft is scanty . . . a rigid airship in free flight is considered to be less liable to danger from electrical discharges than a kite balloon or a non-rigid airship, owing to its metal structure, and the Panel has not been able to trace any fully authenticated case of a rigid airship having been destroyed by electrical discharges. The Panel is of the opinion that directional wireless should be carried by an airship for the purpose of the location of thunderstorms.
>
> "There are, however, a few precautions which can be taken, and to which the Panel desires to draw attention. It is considered essential that all metal parts of the ship should be electrically bonded together. In particular, valves should be electrically bonded to their seats, and care is required in choosing the position of the gas discharge hoods from the automatic valves.
>
> "The Panel is generally of the opinion that it would be advantageous if all fabrics used in an airship were conducting, and that it would be preferable that gas-bag fabric in particular should not contain a layer of insulating material such as rubber. At the same time it realises that this may be difficult to achieve.
>
> "With a view to avoiding electric discharges through the fabric as much as possible, the Panel recommends that small flat metallic studs projecting through the fabric be attached to the top girder of the ship and to the fins. As the nose and stern fins of an airship are most liable to be points of electrical discharge, care should be taken to provide sufficient metal to avoid the risk of local fusings.

> "When riding to a mooring mast, an airship should be effectively bonded to earth."[1]

Questions have been asked of the Secretary of State for Air in the House of Commons as to precautions against the danger of lightning. Sir Samuel Hoare stated in March that the contract for the R.100 contains no specific provision for a safety envelope of inert gas, but that safety arrangements are being considered by a Committee.[2] Some months later he affirmed that hydrogen without any admixture of helium would be used on the trial flight of the R.100 and R.101,[3] and that he was aware of the great prevalence of thunderstorms in the region of Java.[4] He further stated:

> "I understand it is the practice among airship pilots to avoid discharging hydrogen in the neighbourhood of thunderstorms, but no actual evidence of the dangerous results of such discharge is available."

The Captain of an airship would just keep as far away from a thunderstorm as he could. It is quite true that if he were caught in it he would most carefully avoid (as far as possible) valving hydrogen gas in the neighbourhood of electrical disturbances, but readers will have

[1] R. and M., No. 970.

[2] *Parl. Debs.*, 17. 3. 1925. The Report of the Committee is given in full above. The Airworthiness of Airships Panel received the assistance of three meteorological experts in framing the report relating to Protection from Electrical Discharges. It must be presumed that the members of the Panel were cognisant of the fact that airships had already been fitted with directional wireless for ordinary navigational purposes; and the need for avoiding breaks or gaps in any structure where sparking might be dangerous is common knowledge. The report on this subject appears to be final, and the Panel has been able to make few recommendations beyond what is already known by competent constructors.

[3] *Parl. Debs.*, 9. 7. 1925.

[4] *Parl. Debs.*, 7. 8. 1925. The Airship Route to Australia and New Zealand, as shown in *Airways*, May, 1925, touches the Island of Java.

noted in the extracts given from the Log of the R.34, the violent bumps, "700 feet in one bump," occurring even on the extreme outskirts of the storm, and the remark as to the probable severity of the bumps in the middle of the storm. The danger of these bumps is twofold: firstly, the great strain on the structure of the airship, and secondly, that by sudden ascent gas may be automatically valved and a dangerous explosive mixture may be formed and fired. If sufficient gas is not automatically valved the pressure of the gas-bags upon the framework may be serious.

Referring to the flight of the *Norge I.* to Pulham, it is stated that the Airship Meteorology Division of the Air Ministry hope "that the experience and meteorological data gained during the flight of the *Norge I.* from Rome to Pulham will prove of considerable value in preparing the route for the Imperial Airship Service from this country to India, particularly as the Italian airship will traverse a portion of that route. Thunderstorms have to be avoided, if possible, not because of the danger of the airship being actually struck by lightning, but because of the vertical atmospheric currents caused by such storms, and for that reason the route to England via the Rhône Valley is unlikely to be taken, since thundery conditions are frequently to be found there."[1]

The R.34 experienced violent bumps in the sudden upward gusts of wind and rapid changes of temperature accompanying the thunderstorm, but fortunately she was at the edge of the storm and escaped the firing of any explosive mixture which may have been formed, and her structure happily withstood the strain of the vertical upheavals that she experienced and other stresses that obtained.

The reply of the Air Minister (on the 7th August, 1925, to Commander Bellairs' question) that "no actual evidence of the dangerous results of such discharge is available," does not take us much further. If an airship

[1] *The Times*, 10. 4. 1926.

is wrecked by a direct firing of explosive mixture by lightning, she is utterly destroyed, and all in her. The British Airship NS.11 (non-rigid), with a crew of seven, was struck by lightning in 1919, and fell into the sea a blazing wreck. All perished, and no one remained to tell the tale. The French Airship *Dixmude* (formerly the German L.72) set out from Toulon with fifty-three men on 18th December, 1923. She never returned. Ten days later the dead body of her Commander, Lieut. Du Plessis de Grenédan, was picked up off the coast of Sicily. The findings of the High Commission of Inquiry on the *Dixmude* disaster was that the loss of the airship was due to lightning, though " no actual evidence " was forthcoming. The suggestion was made that if the *Dixmude* had used all her fuel, she would be at the mercy of the storm, and " if forced above her ceiling by a violent upward gust of wind, gas would be automatically valved in large quantities. If the ship was struck by lightning under these circumstances there would be little hope of her not being set alight and totally destroyed."[1]

[1] *J. of the R.U.S.I.*, May, 1924.

"We have to proceed cautiously—to study the lessons of the past."—Sir Samuel Hoare, *Secretary of State for Air.*

CHAPTER IV

HOPES—FAILURES—DISASTERS

"In the first months of 1916 the Germans were persevering with their airship attacks, and Admiral Scheer evidently still considered them factors in naval strategy. But they were not accomplishing results,"[1] and surprise was expressed in this country that "Germany with a confidence almost pathetic had continued to build and improve Zeppelins, despite their vulnerability, expense, and need of huge and safe bases."[2] Disaster upon disaster had overtaken them in addition to those attributable to enemy action: of the eleven Zeppelins that came over the north-eastern counties of this country on the 19th October, 1917,[3] five were carried away in the current,[4] scattered, and finally destroyed. "The German Admiral has given shocking testimony as to their vulnerability to enemy attacks and to accident. He stated that of 61 Zeppelins assigned to the German Fleet in the course of the War, 17 with their whole crews were destroyed by the enemy, 28 were lost by accidents, and 6 had to be put out of the Service as useless."[4]

Yet in spite of these experiences there were those in power and authority in this country who believed, or were led to believe, that airships were of value in war and would become a practical and reliable means of

[1] "Naval History of the World War," p. 129, by Thomas G. Frothingham, Captain U.S.R.

[2] *Whitaker's Almanac.*

[3] In the *Journal of the R.U.S.I.*, February, 1926, appeared an article by a German airman. It describes his terrifying experiences in Zeppelins during the War. He was a member of the crew of L.45, one of the airships that met disaster in October, 1917, and his description of the last voyage of the L.45 is thrilling.

[4] The surface winds were light Westerly to N. Westerly, but at 20,000 feet the wind was N. by W. 87 m.p.h. The Zeppelins were obliged to fly high to keep out of gun range, and it was this unknown and unsuspected air current of 87 m.p.h. that carried these airships out of their course to destruction. (*Professional Notes*, No. 42, p. 9.)

transport and communication in peace, for an active airship policy developed.

Faith in airships revived, hope was rekindled. The following appeared in *The Times* shortly after the Armistice:[1]

> "We may now consider what the future holds for lighter-than-air craft in the coming age of commercial and pleasure flying . . . the ship will be able to cruise for sixteen days without descending to be refuelled and overhauled; and an airship capable of this is already planned. The gas capacity of this projected ship will be 10 million cubic feet. Her length will be 1,100 feet, her full speed 95 m.p.h., her cruising range 20,000 miles. Passengers, with their luggage, crew, provisions, merchandise, and so forth, up to a weight of 200 tons, will be lifted by these '10 million' ships, which will include in their accommodation, saloons, drawing-rooms, smoking-rooms, and a 'roof garden' with a lift up to it. An airship is self-contained, for when necessary its crew can prepare meals and take turns at sleeping aboard.
>
> "To-day a British airship of almost 2¾ millions gas capacity is being built. This ship is to have a length of nearly 700 feet, a disposable lift (for passengers, luggage, goods, etc.) of 50 tons, a full speed of 71 m.p.h., a cruising range of 9,400 miles, and a cruising endurance of almost nine days.
>
> "The obvious use of an airship is for merchandise carrying, long-distance cruising, journeys of several thousand miles—and round the world is easily within their compass even now. Ordinarily an airship need not fly at much more than 1,000 feet. This makes for less cold travelling, and also enables those in the ship, especially at cruising speed, to enjoy the scenery.

[1] *The Times*, 19. 12. 1918.

> "An airship always flies on an even keel; it does not bank in turning as an aeroplane does—this makes for comfort and a feeling of greater security. Sleeping in an airship is a calm experience, moving about comparatively simple . . . the engines can be throttled down to a few revolutions, or absolutely stopped with a favourable wind blowing. Engine failure, too, is not such a life or death matter in an airship. The gas-bag will always keep you up until the failure is repaired. Hitherto climb has been considered more important than speed in the airship; now that climb is a minor consideration, more attention can be given to speed. One hundred miles an hour is easily within reach," etc., etc., etc.

Towards the close of the War, and for nearly three years afterwards, trials and experiments in connection with airships were actively pursued, and some fifteen or more large airships were designed. Full-scale tests were carried out with R.24, R.26, R.29, and R.32, large airships launched in 1918; and with R.33, R.34, R.36, R.38, and R.80, vessels launched during the following year.

Mr. Frazer of the National Physical Laboratory, in the *Journal of the Royal Aeronautical Society* of September, 1925,[1] gives details of thirty-nine airship tests and experimental trials. He records that the R.26 (Vickers, Ltd.) had her final trial of four and a half hours at Barrow in April, 1918. Four additional flights in this airship were secured before February, 1919, "when this airship was detailed for mooring out, *prior to its deletion*" —ten months after she was taken over.

> "In August, 1919, information was obtained to the effect that Airship R.29 was *due for deletion*. A communication emphasising the desirability of some record of the performance of this airship was accord-

[1] The R.38 Memorial Prize Essay by R. A. Frazer, B.A., B.Sc., A.F.R.Ae.S.

ingly sent from the National Physical Laboratory to the Airship Design Department, as an outcome of which the necessary facilities were granted, but only for a limited period. During September and October four flights, each of about eight hours' duration, were made from East Fortune; after which the airship was submitted to strength tests and destroyed."

The R.31 made two flights only, both of very short duration (two hours each) in August and October, 1918. On the second flight (26th October, 1918) one of the fins of the airship failed. *No further flights were made and the airship was put out of commission.* On 20th March, 1921, a flight in R.80 terminated after two hours owing to engine trouble and provided little of a satisfactory nature. This was the only flight of the R.80 on which a representative of the National Physical Laboratory was aboard.

The following details of R.33 and later airships are instructive and significant:[1]

R.33:

Launched March, 1919.
Cost, £350,000 approximately (Messrs. Armstrong).
Cost of reconditioning prior to April, 1925, £30,300.
Broke away from mast in April, 1925; returned seriously damaged. Cost of repairs and flying expenses, £46,700.
Total number of hours in the air (to May, 1925), 800.

[1] Particulars of those launched, built, or acquired after December, 1918, only are given. From 1905 airship experiment and research had been carried on in England. The late Mr. E. T. Willows built the first airship in 1905, the second in 1909, and the third (1910) was taken over by the Admiralty. Between 1907 and 1913 the Royal Aircraft Factory at Farnborough had built eight small non-rigid airships. The first rigid airship, the *Mayfly*, constructed of duralumin by Vickers, Ltd., at Barrow-in-Furness and launched in 1911, had a short life—on being taken out for her second trial she was broken and became a complete wreck. Other early types were: No. 1, the

R.34:

Launched March, 1919.
Cost, £350,000 approximately. (Messrs. Beardmore).
Crossed Atlantic in 1919: encountered violent storms which were weathered with difficulty—U.S. vessels despatched to stand by.
Struck high ground and completely wrecked in January, 1921.
Total number of hours in the air, 500.

R.35:

Approximate amount spent on this airship, £75,000.
Never completed—contract cancelled (Messrs. Armstrong).

R.36:

Launched April, 1921.
Cost, £350,000 approximately (Messrs. Beardmore).
Sustained accident during mooring in June, 1921—not flown since.
Partially reconditioned (1925-1926) at a cost of £13,500 for semi-tropical and mooring mast trials—plans cancelled and reconditioning discontinued.
Total number of hours in the air, 97.

R.37:

Approximate amount spent on this airship, £325,000.
Never completed—structure scrapped (Messrs. Short Bros., and the Royal Airship Works, Cardington).

Clement-Bayard (bought 1910, destroyed 1911); No. 2, the *Lebaudy*, damaged on being docked in this country for the first time, and six months later completely wrecked; No. 3, *Astra-Torres*; and the *Parseval*, PL. 18, called No. 4. The "P" Ships, P. 5, P. 6, P. 7..... The many Sea Scouts, Coastals, and improved Coastals (C-Star Class). The R.9 (built by Vickers, Ltd). The "R" vessels of the "23" Class, R.23, 24, .. 26, .. 29, .. to the R.31 and R.32; the subsequent "R" vessels are detailed above.

Admiral Murray Sueter, M.P., referring to the "*Mayfly* which did not fly," said "it was a great success. It was moored to a mast for four or five days in a gale." (*Flight*, 30. 12. 26.)

R.38:

Launched, 24th June, 1921.
Cost, £500,000 approximately (Royal Airship Works, Cardington).
The U.S.A. agreed to purchase this vessel.
Completely wrecked *24th August*, 1921, before being taken over by the U.S.A.; 44 lives lost.
Total number of hours in the air, 70.

R.39:

Approximate amount spent on this airship, £90,000.
Never completed—contract cancelled (Messrs. Armstrong Whitworth).

R.80:

Launched July, 1920.
Cost, £275,000 approximately (Messrs. Vickers, Ltd.).
The airship is not in existence (*Parl. Debs.*, 29. 5. 1925).
Being used for strain experiments (*Parl. Debs.*, 6. 7. 1925).
Total number of hours in the air, 73.

L.64:

German airship surrendered as part of the Peace Treaty.
No flights since arrival in this country.
Scrapped to make room in hangar for R.36.

L.71:

German airship surrendered as part of the Peace Treaty, handed over by the Germans on 1st July, 1920.
No flights since arrival in this country.[1]

These two German Zeppelins (the L.64 and L.71) were "practically their latest airships."[2] The R.80 was not,

[1] These details of our Airship Fleet have been extracted from the replies of the Air Minister to Mr. Viant's questions in the House: *Parl. Debs.*, 27. 5. 1925; 23. 6. 1925; 24. 6. 1925; 29. 6. 1925; 6. 7. 1925; 9. 7. 1925; 22. 7. 1925.

[2] *Aeronautical Journal*, February, 1921.

as her number might imply, the last ship built before flying operations ceased in August, 1921. She was constructed by Messrs. Vickers, Ltd., and followed the R.33 and R.34; she was said to be of an improved design: the hull was of "correct streamline form,"[1] and she had some novel features, the control car having a transparent nose. Apparently she was to be the first of a new and improved class, but after trials lasting seventy-three hours she flew no more.

The story of airships, their failures and disasters, so far as this country is concerned, concludes with the abrupt cessation of flights in 1921, following on the wreck of R.38. The first warning of recrudescence of disaster is furnished by the fortnight's freedom of the R.33 in April, 1925.

Since 1921 we have to look abroad for the experiences of airships. The United States Airship *Roma* in 1922 crashed to the earth in flames—death-roll thirty-four, injured eleven. The French Airship *Dixmude* (formerly the German L.72) in December, 1923, was lost with the crew of fifty-three who were aboard,[2] since when the French have not recommissioned the *Méditerranée*. The U.S. Airship *Shenandoah* had a chequered career, and was completely wrecked, with a death-roll of fourteen, on the 3rd September, 1925,[3] exactly two years after she was launched.

Despite the past history of airships, the British Government in 1923 again became interested in lighter-than-air craft. In the following year airship development was decided upon, and in pursuance of an ambitious policy two great ships were to be constructed. "The present plan was to operate a temporary service to India with these two ships, with a base at Karachi and a temporary calling station at Ismailia." Air Vice-Marshal Sir W. Sefton Brancker, Director of Civil Aviation, a Department specifically formed and charged solely

[1] "Commercial Airships," p. 44. [2] *Vide* p. 263.
[3] *Vide* pp. 273-276.

with the development of aircraft for commercial purposes, has expressed his belief that "airships capable of comfortably accommodating 100 passengers and their baggage, and of crossing from this country to Australia within ten or twelve days was a possibility of the very near future." "With an airship service flying at a cruising speed of 60 m.p.h. New Zealand would be brought as near as Somaliland, Australia as near as Aden was to-day, India as near as Egypt." "These were possibilities which could not be neglected, no matter what it might cost to bring them about."[1]

On the visit of the Colonial Premiers to Cardington on the 17th November, 1926, a scale model of the Government Airship R.101 was exhibited, and much interest was excited by its wonders. The following account is from the *Daily Telegraph*:[2]

> "The R.101 is one of the two airships of the programme sanctioned in 1924. Both ships are of 5,000,000 cubic feet capacity, and will be required to fulfil certain general conditions; they must be able to fly at 70 m.p.h. at an altitude of 5,000 feet, and must conform with certain airworthiness requirements laid down by the Air Ministry. They must have a range at cruising speed, with an ordinary commercial load, of about 4,000 miles. Subject to such general conditions, the designers have a free hand.
>
> "Both airships are being designed to carry approximately 100 passengers, luggage, and 10 tons of mails. The accommodation will include sleeping cabins with two or four berths, promenade decks, lounges, and smoking-room; the dining-rooms will be capable of seating fifty people at a time. The kitchens will make it possible to serve normal meals for passengers and crew, and a five or six course

1 Lecture to Overseas League, *Daily Telegraph*, 20. 1. 1926.

2 *Daily Telegraph*, 18. 11. 26.

dinner should be well within the capacity of the airship steward.

"The whole of the passenger accommodation will be contained within the hull of the airship, while the control car will project slightly underneath the hull. The accommodation will be amidships, divided into upper and lower decks. On the upper deck there will be the lounge, fitted to seat all the passengers, the dining-room, and the main part of the sleeping accommodation, while running along each side of the airship will be two promenades.

"Among other features which are contemplated may be mentioned shower-baths, accommodation for dancing and games, and there should be no difficulty in providing headphones or loud speakers, so that passengers will be able to listen-in to the wireless programmes of the various countries over which the airship will travel."

This description, by Major C. C. Turner, bears a striking resemblance to the equally confident, if more ambitious, forecast of December, 1918.

"*It is only by putting ourselves in harmony with Nature that we get sound instruments, weapons, and performances . . . it is wanted at this juncture particularly in the Services, where economy is so essential and where the belief and practice in false basic principles of fighting and of weapons give rise to so many abortions and so much waste of money.*"—ADMIRAL SIR W. H. HENDERSON, *The Times*, 8. 9. 1925.

CHAPTER V

AIRSHIP POLICY AND PLANS

IN September, 1919, the Government, apparently with a view to economy, decided to curtail their airship programme, and to place certain airships, airship stations, etc., at the disposal of those interested in the commercial development of airships. Plans were submitted, revised, and altered, but no decision was made. In May, 1921, airships were to be "closed down." The question was later reconsidered and further time given.

As a matter of fact, flying operations continued until August, 1921, ceasing entirely after the disaster to R.38. In February, 1922, at the Air Conference, the Secretary of State for Air announced the reprieve of airships until the following June. This was suddenly cancelled in the next month (March, 1922), and negotiations were stated to have been in progress for handing over the fleet of airships to the Disposals Board, but there the matter remained. As it transpired, "none of the airships was sold," they were simply left in their hangars; later some were broken up, and the scrap realised £1,300.[1]

About June, 1923 (or earlier), Commander Burney placed before the Government of the day a scheme for airship development. His proposals included a regular service to India and a subsidy of £400,000 a year for seven years. Commander Burney and the other promoters would form a Company—the Airship Guarantee Company—associated with Messrs. Vickers. It would raise £200,000 at first, and with the initial capital of £600,000 (£400,000 subsidy) would erect the necessary mooring masts and plant, and build an airship of 5,000,000 cubic feet capacity to test the route to India. If the airship passed the test and flew to India in 100 hours flying time, the yearly subsidy would be automatically payable for the following three years, and the

[1] *Parl. Debs.*, 6. 7. 1925.

subsidy for the remaining three years would be dependent upon a weekly service being maintained.

So well was the scheme presented, that in spite of the disheartening experiences of airships in this and in other countries, Sir Samuel Hoare (then, as now, Secretary of State for Air) stated in July, 1923, that "the Government had accepted the scheme in principle," subject to financial details being settled by the Treasury. It was about to be formally passed and the sum required put on the Air Estimates, when the Government resigned and the Labour Government came into power (January, 1924).

The new Prime Minister announced he was "considering the matter." Commander Burney, in a letter to *The Times* on 11th March, 1924, spoke of the "very grave decision on a matter of national moment," for another Committee had been appointed to investigate the Burney Scheme which "the late Government had taken under its official wing."

So confidently were the potentialities of airships advocated that the Government seem to have been convinced of the future of airships, and decided upon a policy which, while "savouring of compromise," entailed commitments, the extent of which could not have been known or appreciated. The Prime Minister, Mr. Ramsay MacDonald, announced on the 4th May, 1924, that "after careful consideration H.M. Government have decided to reject the scheme put forward by the Airship Guarantee Company (commonly called the Burney Scheme). At the same time H.M. Government share the view of their predecessors that it is essential to carry into effect a constructive programme of airship development. They propose accordingly to authorise a comprehensive programme of 'lighter-than-air' research and experiments at Cardington, including full-scale experiments with one of the existing ships which will be reconditioned for the purpose, and to undertake the early construction of a new airship of a capacity of

5,000,000 cubic feet. Simultaneously, the Air Ministry will give the Airship Guarantee Company the first offer of a contract for the construction of a second ship for commercial purposes. Further, the Air Ministry will undertake the construction of a terminal and intermediate Base overseas, with the necessary facilities to enable these two ships to operate with safety between England and India."[1]

A Panel was appointed—the Airworthiness of Airships Panel—by the Aeronautical Research Committee of the Air Ministry, "to consider and report on questions affecting the airworthiness of airships having reference to broad principles only," and to consider the question of deterioration in material. This Panel first met on the 14th May, 1924, and issued its first Report in the following October.[2] Its recommendations included that "arrangements should be made for independent inspection of materials and workmanship. As the properties of some of the metals used depend on the handling of the material during construction,[3] it is recommended that a resident engineer representing the Air Ministry be appointed to each establishment building ships, who will be responsible for ensuring an adequate standard of workmanship," and it also suggests that "designers should submit their methods of calculation to the Air Ministry for approval," and that "in problems of special difficulty the help of the Aeronautical Research Committee might be requested."[4]

[1] *The Times*, 15. 5. 1924.

[2] *R. and M.*, No. 970, published July, 1925.

[3] Duralumin requires extreme care in manufacture; *vide* p. 9, footnote 3.

[4] The Report states: "In a framework possessing the degree of redundancy exhibited by a typical airship structure the determination even of the primary stresses presents a problem of extreme complexity. . . . Secondary stresses are so intimately connected with details of design that it is hardly possible to treat them except in relation to some specified part of a particular airship. The word 'secondary' must not be taken as indicating relative unimportance."

Having decided to build the 5,000,000 cubic feet airship R.101 at Cardington, the Air Ministry had immediately to proceed with the enlargement of the hangar there, which alone has entailed a fresh expenditure of little short of £100,000.

With regard to the construction of the airship, which is to be mainly of stainless steel, it was stated[1] that during the year April, 1925, to April, 1926, "progress was made with design and experimental work for R.101. Certain preliminary constructional work is now in hand, the main hull girders being due for delivery during the summer." In October, 1926, it was reported: "One of the girders has been completed, and certain preliminary tests have successfully been carried out."[2] In spite of the fact that this constructional work has been handed over to a private firm[3] and the development of the proposed type of engine has been entrusted by the Air Ministry to private enterprise, it yet appears that a large staff is retained at Cardington. The Air Estimates for 1926 show a technical and clerical staff at Cardington of 118, with a salary list of £36,000, in addition to wages amounting to £58,000.

The construction of the second giant airship, R.100, is being carried out by the Airship Guarantee Company. The contract price of this—the 'Burney ship'—is given as £300,000, and in addition a contribution of £50,000 has been made towards the capital expenditure incurred by the contractors, the Airship Guarantee Company.[4] This Company (of £3,000 total subscribed capital) received from the State the whole of the £50,000 voted towards its capital expenditure on shed, plant, etc.,

[1] Command Paper, No. 2707. [2] *Flight*, 14. 10. 1926.

[3] *Vide* p. 157, note 3.

[4] The Airship Guarantee Company registered 29th November, 1923, as a private Company, nominal capital £5,000, with £3,000 (in £1 shares) fully paid up; 2,993 shares are held by Vickers, Ltd. On 1st August, 1924, the nominal capital was increased to £100,000, but (according to Return 31st December, 1925) no more money has been put into the Company.

together with £100,000 as a first instalment of the contract price of the airship, on the signature of the contract in 1924.[1] A further sum of £60,000 appears in the 1925 Estimates,[2] and £30,000 in the 1926 Estimates, a total of £240,000. In the Official Report for the period 1st April, 1925, to 31st March, 1926, it is stated:[3] "In the past year the Airship Guarantee Company have been carrying out preliminary experimental work of various kinds. The airship R.100 will be built at their works at Howden, Yorkshire." On the 28th July, 1926, the Secretary of State for Air, Sir Samuel Hoare, reported regarding the progress of construction of this airship: "I am informed that the Company have completed the tests necessary before passing from the stage of design and research to that of construction, and are now making the girders for the hull of the airship."

This ship is of a new design and construction, and shows "radical departures from the form originated by the German Zeppelin engineers."[4] embodying features for which Commander Burney is stated to be responsible.[5] The proposed type of engine, however, has not materialised, little is known of the "inert gas," while the enormous gas-bags, by no means an inconsiderable item of giant airships, will be manufactured for Commander Burney by the Zeppelin Company. It is presumed that the ever-changing details of design of this vessel, and the duralumin of which it is to be constructed, are periodically approved and passed by the Air Ministry.

In the meantime the provision of housing and other

[1] *Parl Debs.*, 28. 7. 1926.

[2] The sum of £60,000 also appears in the 1925 column of the 1926 Estimates, *without any remark*. In reply to a question (8. 12. 26), the Secretary of State for Air said: "The sum of £60,000 which was taken in the Air Estimates, 1925, was not earned and lapsed as an unspent provision. A sum of £30,000 has been taken in the current year's Estimates, and is expected to be earned and paid."

[3] Command Paper, No. 2707.

[4] *J. of the R.U.S.I.*, November, 1925, p. 827.

[5] *Airways*, May, 1925, p. 280.

facilities for the two new airships is proceeding apace. The following gives the estimated cost,[1] omitting works under £2,000 each:

	£
Cardington:	
Alterations to airship shed	98,500
Mooring mast	50,000
Improvements in water supply	2,600
Conversion of electric equipment	2,300
Egypt:	
Mooring mast	53,000
Gas plant	22,000
Roads and external services	14,000
India:	
Airship shed	172,000
Mooring mast	53,000
Roads and external services	33,000

By the end of the financial year 1926 much money will have been expended on the new airship policy, yet according to the Official Report issued December, 1926:

> "It remains to build the airships; to overcome the mechanical difficulties of the heavy oil engine; to finish the sheds and masts; to complete the meteorological investigation; to establish the meteorological and wireless organisation; to carry out the home trials,[2] and to fly the two airships to India and back."

All this public money is being expended, but the facts which govern the possibility of airship services do not appear to have been examined; the airworthiness of airships is the subject of grave doubt. The scepticism in the public mind is well founded. Sir Samuel Hoare, the Secretary of State for Air, stated in reply to a question:[3]

> "I should prefer not to treat the matter as proved until one or more vessels have actually been tried out on a commercial route."

[1] The Air Estimates, 1926.

[2] One charge of hydrogen for each airship will cost anything from £2,500 to £7,500; *vide* p. 49, para. 4.

[3] *Parl. Debs.*, 27. 5. 1925.

Speaking eighteen months later at the Imperial Conference in London (October, 1926), he said:[1]

> "The two airships should, with a normal load of weight and 100 passengers, be able to fly without refuelling in good weather a distance of some 4,000 miles. Accommodation is being planned for 100 passengers, promenade decks, outside cabins, and ample smoking and dining rooms."

But in spite of these ambitious schemes there is evidence of doubt, if not of anxiety, in the mind of the present Secretary of State for Air. He emphasises the fact that he has examined his technical and scientific advisers upon "all the points of danger—the danger *inherent* in so large and fragile a structure, the danger of storms of unexpected and incredible ferocity, and the danger of conflagration in a ship composed of highly inflammable material." He had examined his experts "again and again," and he affirmed that:

> "Great progress has been made both on the theoretical and practical side during the last two years; we can claim to have made the fullest possible use of *scientific theory*, of full-scale and model experiment, of the testing of materials, and, by no means least important, of the study of meteorology.
>
> "There is *to-day* no technical or operational reason why, by aeroplane or airship, London should not be brought within a fortnight of the farthest cities and territories of the Empire. There is no technical reason why the journey to Canada should not be reduced to 2½ days, the journey to India 5 days, to Cape Town 6 days, to Australia 11 days, to New Zealand 13 days. These claims I can, *of course*, support by detailed and expert evidence."

Commander Burney however does not appear now to place so much confidence in "scientific experts," nor

[1] *The Times*, 29. 10. 1926.

are his doubts so easily removed; indeed he seems to be losing his faith in airships. In an interview at Howden in March, 1926, Commander Burney stated:[1]

> "In October, 1924, the Government entered into a contract with the Airship Guarantee Company whereby we should design and construct a ship and hand it over to them for trials. After they have been completed it will be considered whether a commercial and passenger airship service between England and Australia is a working proposition.[2] *Of course*, it is impossible to estimate how the route will work out. Everything depends on the behaviour of the craft during her preliminary tests. The Government is also to begin a ship of their own design at Cardington, so you will see there is some useful competition in the idea.[3] Non-inflammable gas (the nature of the gas is not stated) is to be used for obvious reasons, but as to how far the airship will in any measure take the place of other craft for commercial and passenger travel, no one can yet foresee."

In strong contrast to these 'scientific' ideas and uncertain hopes is the opinion of an experienced seaman. Admiral Sir W. H. Henderson, treating of the navigation and operation of such vessels, is convinced of their futility; he says:[4]

> "An airship is only a fine-weather craft, capable of making trips in selected weather, or for use for reconnaissance on selected days from some few definite positions," and he calls attention to "statements in regard to the value of airships which require serious examination if the public are not to be misled and vast sums of money spent before it is too late."

[1] The *Daily Sketch*, 1. 3. 1926.

[2] After her trials the Company have the option of purchasing the airship for £150,000. (*J. of the R.U.S.I.*, February, 1925.)

[3] The most striking and disquieting feature of this competition in ideas is the use of different metals for the structure of the two ships.

[4] The *Evening Standard*, 10. 6. 1925.

"*The worst of science is—it stops you thinking.*"—
Anatole France.

CHAPTER VI

EXPERIMENT AND RESEARCH

It is a matter of conjecture whether the Conservative or the Labour Government would have revived airships after the period of oblivion had not Commander Burney (with Messrs. Vickers) advocated a scheme for building airships with a Government subsidy, for a proposed regular service to India and the East; but be that as it may, the Government of the day decided upon the policy of airship development and authorised a further comprehensive programme of experiment and research and the building of two giant airships:

> "The goal was the ability to fly to India in comfort and without change in the space of 100 hours; the problem was to design and construct a ship of vast capacity with little help from past experience."[1]

In pursuance of these plans, and in order to obtain essential data for the construction of the two giant airships, it was decided to use R.80—a vessel that had cost £275,000 and had been seventy-five hours in the air –for strain experiments, in the course of which she would be broken up; and to recondition the two remaining ships—the R.36 for semi-tropical trials and the R.33 for trial flights at home.

The R.36, launched in April, 1921, was a vessel which had cost £350,000. She had been in the air for ninety-seven hours only, for on the 5th April, 1921, an accident had occurred after five hours' flight, and one rudder and one elevator became inoperative; in June of the same year she sustained an accident during mooring and has not been flown since. On December 16th, 1925, in a lecture on Air Communications in the Middle East, Air Vice-Marshal Sir Sefton Brancker, Director of Civil Aviation, replying to a question on the proposed experimental Egyptian flights of the R. 36, said:

[1] *The Times*, 31. 8. 1925, British Association Meeting.

> "The present intention is that she shall go to Egypt next summer, where she will fly for some time and gain experience in working airships under more or less tropical conditions, about which no one in the world knows very much at present."[1]

A fortnight later it was announced that the reconditioning of R.36 for these semi-tropical trials would not be continued.[2] Her flight to Egypt was thus abandoned after an expenditure of £13,500 towards this end. The Secretary of State for Air stated:

> "The flight of the R.36 to Egypt will not now be carried out, since the experience to be gained by it, though desirable, is not considered essential."[3]

In the meantime the R.33 (a vessel launched in 1919) had been reconditioned for experimental flights in this country, and on the 2nd April, 1925, was ready for the air. She flew to Pulham in fine weather. On the night of the 6th-7th April, "she took the first flight for specific experimental trials."

> "The full tests intended to have been made" (for which the R.33 was expressly reconditioned) "could not be carried out as some of the pressure-recording instruments were not functioning with sufficient accuracy. There are two or three hundred tiny orifices spread over the hull and another hundred in the fins, all connected to manometers, so that the

[1] *J. of the R.U.S.I.*, May, 1926.

[2] *Daily Telegraph* and *Evening Standard*, 2. 1. 1926.

[3] Memorandum to the Air Estimates, 19. 2. 1926. Upon these changes *Flight* comments: "We go off the deep end and 'talk big' about 5,000,000 cubic feet airships. Then our airship authorities say that the building of such airships will require a certain amount of full-scale experimenting. The work is taken in hand and a start made. Another change of mind, and airship flying is once more closed down. After all the vacillation shown during the last few years one is almost tempted to suggest handing the whole of the airship work over to the Navy."

actual pressure on various parts of the ship can be recorded during the predetermined manœuvres, and, as can be imagined, a high degree of exactitude is required in every instrument."[1]

Major Scott stated:[2]

> "Unfortunately, owing to a slight mechanical defect in the recording apparatus the flight was of no value, from a scientific point of view, and the bad weather that followed made it necessary to postpone further flights."

The reconditioning and fitting up of the R.33 for these proposed experiments had cost £30,000.

Ten days later (16th April), before she could undertake another flight, she broke away from her mooring mast. The history of the thirty hours she spent in the air need not be recounted. When the airship returned she was put safely into her hangar—the cost of this operation in civilian labour alone amounting to £193.[3] R.33 had been out for two weeks only. The work of reconstructing 60 feet of new metal nose and the repair of the mooring mast occupied five months. In September she was ready to take the air again and make the "one more long flight required to give all the information"[4] necessary for the construction of the new giant airships. On the 5th October (1925), when "the atmospheric conditions were perfect," the R.33 emerged, made a flight of nineteen hours, carried out a series of aerodynamic tests, and returned to her hangar.[5] Subsequently during the next nine weeks some four local flights were taken in very

[1] *The Times*, 8. 4. 1925.
[2] *Airways*, May, 1925, p. 270.
[3] *Parl. Debs.*, 29. 6. 1925.
[4] Major Scott in *Airways*, May, 1925, p. 270.
[5] It appears that only on one occasion during the whole nine weeks did the airship ride at the mooring mast. The *Norge I.* also preferred the hangar at Pulham on her short stay of two and a half days in April, 1926.

favourable weather. On the last flight the experiment was accomplished of releasing an aeroplane, and by careful adjustment of speed attaching it again to the airship during the flight. Immediately afterwards the R.33 returned to her hangar, where she remained until the following season. It was stated by the Secretary of State for Air that the direct expenditure, including her reconditioning at the beginning of the programme, her repair after the breakaway at Pulham, and all flying expenses, had by this time amounted to £77,000.[1]

On the 5th October, 1926, exactly one year after her last emergence, the R.33 made a flight in very favourable weather to try out again the releasing of aeroplanes. Two fighting planes had been carefully attached to her in her hangar, and she was moved out to take the air once more. One aeroplane was successfully launched; the propeller of the other refused to function, and the airship proceeded leisurely to Cardington carrying the aeroplane under her. By that time matters were righted, and there the plane was released and flew safely to ground. The airship, instead of being attached to the mooring mast, was then brought down, sustaining in the operation some landing injuries, and housed in the great hangar of the Airship Base. On the occasion of the visit of the Colonial Premiers on the 17th November, 1926, the weather was deemed too unfavourable for the mooring operation, and the Premiers, who have been asked to consider the immediate building of mooring masts for the reception of the giant airships, missed a demonstration of the R.33 riding at the mooring mast at Cardington.

It is calculated that since the R.33 was projected, this country has sunk not less than £2,405,000 on the construction and repair of airships; to this sum must be added flying expenses, the cost of hydrogen gas, personnel, hangars, mooring masts and landing grounds. The total expenditure must have been very great, yet not 1,600

[1] *Parl. Debs.*, 3. 5. 1926.

hours[1] have been flown in all at the cost in craft alone of £1,500 for every hour flown. Little has been achieved except a spectacular flight to America, while the vulnerability of airships has been established beyond doubt.

The loss of the *Shenandoah* has disturbed American plans and given rise to a demand for further 'research' pending the construction of monster 6,000,000 cubic feet airships. Accordingly "the *Los Angeles* has been converted into a veritable floating scientific laboratory."[2] The ship is fitted with all manner of instruments, and scientists from the Navy, National Advisory Committee for Aeronautics, and the Massachusetts Institute of Technology have been on board collecting elaborate data. This account irresistibly suggests the materialisation after a period of 200 years of Swift's Floating Island of Laputa.

METEOROLOGY has assumed great importance because of the utter dependence of aircraft upon weather conditions. Commander L. G. Garbett, R.N., of the Meteorological Office, Air Ministry, states:[3]

> "Much has been written on the subject of aircraft development, but few writers, I think, have emphasised sufficiently the importance of meteorology, which indeed is the dominating factor in Air Navigation."

It has been pointed out that an airship experiences difficulty in ascertaining the wind—the current she is actually in—and that she must depend upon reports from ships or wireless stations on land as to the velocity and direction of the wind, the existence of a depression

[1] Half of the total is to the credit of R.33; R.34 accounted for 500 hours, including her voyage to the U.S.A.

[2] *Army and Navy Journal* (U.S.A.), 5. 6. 1926.

[3] "Charting of the Upper Air," in *J. of the R.U.S.I.*, November, 1925.

and the direction in which it is moving, and even information as to her own position and height. The dependence of all aircraft upon meteorological conditions cannot be over-emphasised. The process by which an airship at sea is informed of the weather actually prevailing or likely to prevail in its neighbourhood is sufficiently roundabout to be amusing. In the first place, a vessel is required in the neighbourhood of the airship to inform the 'Clerk of the Weather' by W.T. the height of its barometer. The airship cannot do this herself as her barometer readings are not reliable, and furthermore the airship may be in ignorance of her own position. This barometric reading having been collated with other readings from vessels at sea, a forecast is transmitted to the airship by W.T. This weather forecast may or may not be received by the airship, since the most casual acquaintance with W.T. at sea reveals its great uncertainty.

Various schemes for forecasting the weather have been proposed:

> "At a meeting of the Royal Meteorological Society, Professor Van Everdingen suggested that lack of knowledge of existing circumstances was one of the principal causes of their inability to predict the weather accurately even for short periods of only twenty-four or thirty-six hours. This was the reason of their efforts to establish a *network of ship stations in the Atlantic, and their daily attacks on the atmosphere with pilot balloons, kites, registering balloons and aeroplanes.*"[1]

Practically the whole of aeronautical 'research' is financed by the Government, and for 1926-1927 the expenditure for Meteorology is estimated at £135,000.

The Meteorological Department of the Air Ministry issues a handbook for airmen. It is apparently intended

[1] *The Times*, 23. 4. 1925.

to correspond with the Sailing Directions used at sea, and—

> "contains full particulars of the Meteorological bulletins normally issued at least three times a day by the various countries, including ordinary ground observations of weather, wind, temperature, humidity, and height of the barometer for a number of places. The bulletins also give information about conditions in the upper air, reports from ships at sea, and weather forecasts. The area dealt with extends westwards to America, eastwards to Siberia, northwards to Spitzbergen, and southwards to Northern Africa . . . changes in both British and foreign reports were published in a series of fifteen supplements."[1]

To meet the requirements of aircraft "daily charts of the wind and weather over the route to be traversed must be prepared from observations received by wireless, but in addition to this, *complete charts of the mean winds at the different layers are absolutely necessary*,"[2] for if airships cannot face the meteorological conditions as they occur, they must have sufficiently great speed to escape from them, or must avoid them by rising into a more favourable area.

The constant winds—as far as they exist—are already charted, and the general circulation of the atmosphere is known, but—

> "The advance of long-distance aviation demands accurate information of the winds in those regions for which no observations are available; and on air reconnaissance flights the importance of a knowledge of the meteorological conditions at different heights is essential. Airships, in order to be able to keep

[1] *The Times*, 22. 4. 1925.

[2] "Charting of the Upper Air," by Commander L. G. Garbett, R.N., *J. of the R.U.S.I.*, November, 1925, p. 731.

the air as required, must be supplied with all the meteorological information available, so that they may select the route best suited to them at the time, both on account of economy of fuel, by utilising the most favourable (or least unfavourable) winds, and on account of the necessity of avoiding dangerous or undesirable phenomena—in particular, thunderstorms. These should be circumnavigated, not only because of the possible danger from lightning, but also owing to the very disturbed and turbulent state of the atmosphere in their vicinity."[1]

The upper air is the subject of investigation. A new department, the Airship Meteorological Department, was formed soon after the Airship Staff was appointed. It is stated that—

"it is not a branch of the Meteorological Department which is responsible for our weather forecasts, but was constituted for the purpose of studying the regular and non-regular air currents and the conditions under which danger may be avoided by airships and the wind utilised as an aid to travel."[2]

A particular Commission is sitting, and is—

"concerned in discussing the best methods of exploring the upper air, and of securing the publication of the result in such a form that they are available to all interested. *The whole region of the atmosphere up to* 50,000 *feet or* 60,000 *feet*" (Mount Everest is only 29,002 feet) "*is the subject of investigation now for meteorological purposes*, and the

[1] "Charting of the Upper Air," *J. of the R.U.S.I.*, November, 1925. Referring to the flight of the *Norge I.* it was reported: "The Meteorological factor which will decide the time of departure is now the probable weather at Oslo rather than here, and Mr. Gibbett, the officer in charge of the Airship Meteorological Section of the Air Ministry, is now concentrating on the forecasts for that section." (*The Times*, 13. 4. 1926.)

[2] The *Daily Telegraph*, 21. 4. 1925.

> usual method is to send up instruments in free balloons. These eventually burst and become parachutes, so that the instrument is not damaged when it returns to earth. Directions are contained on the instrument for returning it to the source of origin."[1]

A Report[2] of the investigation of the winds of the upper air, and the fall of these pilot balloons, has been issued by the Air Ministry. A postcard (Form 3638) is attached to each balloon requesting the finder to return it to Kingsway, stating where and when it was found. These forms were brought into use in December, 1922, and the Report deals with the following year, December, 1922, to December, 1923. No figures are given of the number of balloons sent up during that period, but 4,500 may be taken as a rough estimate. Of all these *only three* were seen falling.

It is stated:

> "This method of investigation is naturally attended by many uncertainties; the height to which the balloon ascends is uncertain, and its behaviour when it springs a leak or bursts is uncertain. Also the time at which the balloon actually falls is very rarely known; out of 1,000 *cards returned* only three have been seen falling—one in Ireland, one in Holland, and one in Germany."
>
> "In most cases the direction of the point of fall is intimately connected with the wind at some high level . . . but there are cases in which the bearing of the point of fall does not give the direction of the upper wind at all."

The case of the balloon that fell in Germany, picked up just as it fell, affords positive evidence, and is full of interest. It was despatched from Calshot at 4.30 p.m.

[1] *The Times*, 15. 4. 1925.
[2] *Professional Notes*, No. 42, Meteorological Office, Air Ministry, issued December, 1925.

on the 23rd October, 1923, and was picked up four hours later at Leipzig. It thus travelled approximately 570 miles in that time. There was nothing in the observations that day to indicate that a high wind was in evidence in the upper regions. The wind was westerly and about 40 m.p.h. below 7,000 feet, and yet the average speed of the balloon was 143 m.p.h., implying a maximum speed, at a great height, of 250 m.p.h., and demonstrates the tremendous velocity of westerly winds in the upper regions of these latitudes.

In conclusion the writer states that many of the long runs of these balloons may be due to the high speed of westerly winds rather than that the balloon floated for many hours, and—

> "the investigation of the upper air by means of Form 3638 attached to pilot balloons is attended by so many uncertainties that the method cannot possess any exactness."
>
> "It is doubtful whether this method is any better or even as good as the careful observation of high cloud."

It has already been shown[1] that the wind changes in speed with height above the ground, but whereas westerly winds, the prevailing winds in our latitudes, tend to increase with height, an easterly wind increases up to 3,000 feet and then tends to decrease. It is said that it is not an infrequent occurrence that the wind at 20,000 feet is in the opposite direction to the wind that is blowing at the surface of the earth, and in the region of the Trades there is a counter-Trade sometimes as low as 6,000 feet, sometimes as high as 30,000 feet.[2]

The possibility of finding in the upper regions a more favourable—or less unfavourable—area is highly conjectural, but that a commercial airship cannot rise to great heights is easily demonstrable.

[1] *Vide* p. 14, para. 4.
[2] "Charting of the Upper Air," *J. of the R.U.S.I.*, p. 730.

An airship rises, with the weight she carries, just as high as her buoyancy allows her: she may be made to ascend higher on an even keel by discharging ballast and lightening her, or she may be made to ascend by inclining her elevator planes and by using her engine speed to give an aerodynamic lift to balance the excess of her weight over her buoyancy. This buoyancy—lift—decreases as height increases. At a height of 2,500 feet it is about 8 per cent. less (or 12 tons in R.100), at 4,000 feet about 12 per cent. less, and at a height of 10,000 feet the reduction is as much as 27 per cent.[1]

It has already been shown[2] that the theoretical maximum useful load that might be carried on a 2,200 mile voyage by the R.100 is less than 10 tons. Under good conditions she might just lift such a load, but as has been pointed out, if the weather is misty or there is rain or snow on the airship the lift will be reduced, and the airship must relieve herself of some weight—fuel or useful load—or postpone her departure.[3] With her load she must be in trim and able to rise by her buoyancy—*static* lift—and clear her immediate obstacles (hangar, wind screen, and mooring mast) before engaging her engines and rising by her *aerodynamic* lift.

Only if the airship carried no useful load whatever could she rise by her buoyancy to 2,500 feet at the start of a voyage; and if fully loaded, any height attained at the beginning is gained by aerodynamic lift, which introduces *drag* and loss of speed.[4] But height cannot be gained, if the bags are full, without valving gas, and the airship should avoid undue loss of gas at the start of a voyage by keeping as low as possible until sufficient fuel has been used and static lift from buoyancy[5] available

[1] From Humphrey's "Physics of the Air."

[2] *Vide* p. 33.

[3] As did the Z.R.3 before crossing the Atlantic; *vide* p. 253, para. 4.

[4] *J. of the R. Ae. S.*, February, 1924, p. 109: Angle of 10 degrees gives approximately 10 per cent. decrease in speed.

[5] In the R.100 kerosene-hydrogen engines were proposed. With these engines, the increase of buoyancy (the tendency to rise higher)

to give some freedom of choice in flying heights. Referring to this point the late Air Commodore E. M. Maitland wrote:

> "It is interesting to remember that when an airship sets out for a long-distance voyage, carrying her maximum allowance of petrol, she can only rise to a limited height at the outset of her journey without throwing some of it overboard as ballast. As she proceeds on her voyage she can, if so desired, gradually increase her height as the petrol is consumed by the engines. For this reason the next few hours will form one of the most anxious periods during the journey, as Scott, with 4,900 gallons of petrol on board, weighing 15·8 tons, has to keep his ship as low as possible."[1]

On starting R.34 had just sufficient buoyancy to get clear of her shed, and she was driven up by her engines to the necessary height (1,500 feet) to avoid the danger of colliding with high ground in the fog. This necessitated loss of gas to the extent of over 2 tons lift.[2]

When the U.S. Airship *Shenandoah* made her record voyage in 1924, she carried no useful load. Nevertheless she was obliged to throw overboard her ballast and even petrol before she could rise to 7,000 feet, and the bags of precious helium gas "were swollen and straining against the nets, and gas flowed in a steady stream through the safety valves."

This "steady stream" of helium gas into the atmosphere, represented over £55 for every 100 feet rise above pressure height.

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as the airship gets lighter, due to consumption of kerosene fuel, is checked by the decrease of buoyancy (tendency to fall), due to consumption of hydrogen as fuel. *Vide* p. 118.

[1] "Log of H.M.A. R.34," p. 8.

[2] *Ibid.*, Appendix VI.

It is clear that general flying heights above 2,500 feet mean the relinquishing of useful—paying—load and the forfeiture of any margin of fuel and a great expenditure of gas. Towards the end of a journey higher altitudes can be attained due to the lightness of the ship owing to exhaustion of fuel, but that does not affect the load taken aboard at the start of a voyage.

But for commercial flying comfort must be considered, and temperature is an important factor. On an average the temperature decreases 1° Fahrenheit for every 300 feet of ascent. At the height of 10,000 feet in Central Europe the mean winter temperature is 16 degrees below, and the mean summer temperature only 4 degrees above freezing point. During the day the sun's rays will cause much superheating of the gas, in spite of the means employed to give the cover as perfect a reflecting surface as possible. The physical discomfort of a freezing atmosphere, a glaring sun, and a high altitude of two miles or so, need not be enlarged upon, but discussion of these discomforts[1] and the navigational difficulties at this height is somewhat academic, for considerations of lift already discussed preclude such a flying height.

Whatever favourable currents may or may not be flowing at higher levels, these heights are quite impractical and uncommercial, and cannot be taken advantage of. No experiment and research can affect the presence and power of electrical disturbances in the air, can increase the lifting power of hydrogen or helium, can alter the direction of the air current, abate its speed, regulate its

[1] The German helmsman of the L.45 writes: " There was another trial—the cold! That was far worse than the height in its effects. It was all very well for the short trips, that lasted only two or three, or even six hours at a high altitude. That was play compared to the long flights that now fell to our lot. Cold and height went together—often even in the summer nights when these were short and the days had been hot. But in the autumn things were to grow worse. . . . They sought to go still higher up, and we suffered still more from height and yet still more from the cold as the summer days grew shorter." (*J. of the R.U.S.I.*, February, 1926.)

incidence, or overcome its inconstancy—these will always be the vital and unalterable factors of air navigation.

In airship development the Government do not seem to be sure of their ground, and their policy appears to be founded upon the shifting sands of theory and opinion rather than upon the solid rock of truth. On the occasion of the presentation of medals to the crew of the R.33, Sir Samuel Hoare stated:

> "When I received the telegram telling me that R.33 had broken away . . . I realised at once that a turning point had been reached in the history of airships. If this were another airship catastrophe there would be an end for a generation to all the schemes that we had planned," and he "emphasised the obligation under which the country lay to the crew of the R.33, who by their devotion to duty had prevented alarmists stopping airship development."
>
> "If the crew had failed to navigate the airship—indeed, if Flight-Lieutenant Booth had decided to sacrifice the airship, and, while saving the lives of the crew, to destroy it by landing in Holland—it is my firm conviction that airship development would have been stopped for a generation. Airships have many critics, and besides the airship critics there are thousands of timid people who dislike great experiments that may lead to big changes in established ideas."[1]

It is difficult to understand Sir Samuel Hoare's allusion to airship critics, for adverse criticism has been remarkable, so far as the Press is concerned, by its absence. Indeed the Press has been so unanimous in its advocacy of the value of airships and aircraft generally that at the luncheon of the London District of the In-

[1] *The Times*, 5. 6. 1926.

stitute of Journalists on the 7th July, 1925, the principal guests, Sir Samuel Hoare and Commander Burney, returned thanks for the support that the Press had given to airship development, and the great power of the Press in this country was duly acknowledged.

So powerful indeed is the hypnotic effect of official prophecies and ceaseless propaganda that even the great shipping companies are beginning to take these statements seriously.

At the Annual Meeting of the Orient Steam Navigation Company held in December, 1926, the Chairman, speaking of speed in ocean travel and of the proposed 22-knot service,[1] said:

> " We believe the future lies rather in the air than on the ocean."
>
> " The Chairman of the Company (Sir Kenneth Anderson) has expressed that opinion at these meetings in past years, and we have good authority for holding it with increasing confidence to-day."
>
> " I would refer you to the statement made at the Imperial Conference by the Secretary of State for Air to the effect that the ultimate objective of his policy is to bring the most distant parts of the Empire within a fortnight's journey of London."
>
> " The Secretary of State also drew attention to the great potentialities of the airship as providing

[1] Referring to the proposed 22-knot service to Australia, the Chairman (Mr. I. C. Geddes) remarked that "such a service could only be maintained—if maintained at all—at the cost of a formidable subsidy. . . . I need hardly say how disturbing and speculative a factor such an artificial development would introduce. To create a standard of speed by subsidy would be to put saloon passengers on the dole. . . . The lower the fares, the greater the opportunity of travel to the majority of our passengers. For the relatively small number of passengers and the relatively small percentage of mail matter of urgent moment we believe that the future lies rather in the air than on the ocean." It is noteworthy that Mr. I. C. Geddes does not carry his strictures on subsidies and State doles into the realm of airships in particular and civil aviation in general.

a safe, comfortable, and rapid means of non-stop transport over long distances. The Government hope to undertake airship demonstration flights to the Dominions in about two years' time."

"Sir Sefton Brancker, at the James Watts Dinner, also repeated that the slogan was 'Every Capital in the Empire within a fortnight of London.' That, he added, was no vain boast; it could be done both by airship and aeroplane; the most romantic thing to be produced this century would be airships. Last, but not least, I would refer you to the resolutions of the Imperial Conference itself, in evidence of the impression made upon the minds of its members by Sir Samuel Hoare's statements."

"The first step to wisdom is to recognise things which are false."

CHAPTER VII

THE PROPOSED EMPLOYMENT OF AIRSHIPS, AND THEIR FUNCTION IN RELATION TO AEROPLANES

IT is clear that Airship Schemes are stimulated by those who seek to supply by another form of aircraft[1] what in aeroplanes is found to be lacking; and a vessel of totally different capabilities, not subject to the precise limitations and disabilities of aeroplanes, is being brought forward now that the aeroplane has nearly reached its ultimate development. Aviation made tremendous strides during the War, and now—

> "the capabilities of the aeroplane as regards speed, ascending power, and stability are developed almost to perfection."[2]
>
> "From now on, the most to be expected is gradual refinement of details."[3]

If we disregard the fundamental disability of airship navigation due to the translatory movement of the medium in which it operates, and if we further disregard the weaknesses and lack of useful lift of the machine itself, the airship in theory has attractive powers which in the aeroplane are notably absent, and certain qualities that in some respects make her superior to it. An airship's endurance in the air is clearly greater. She can travel by night and in a fog much more safely than an aeroplane,[4]

[1] *Vide* pp. 123-128. [2] *Airways*, May, 1925, p. 277.

[3] "Naval Aviation" (U.S.A.), p. 35.

[4] Readers will recall the Aerial Derby of 3rd July, 1925, and the experiences of the competing aeroplanes in the prevailing fog. The superiority of the airship in a fog was demonstrated by the R.33 on her night flight, 6th-7th April, 1925. She was in the air exactly fifteen hours—more than half the time (8½ hours) in fog. She left Pulham at 9 o'clock in the evening, flew over London, and found fog on her return. "When she reached Pulham at 4 o'clock in the morning, the aerodrome was also in a thick fog, so the cruise was extended over parts of Suffolk. At 5 a.m. Pulham was still invisible, and the R.33 then went over the coast, where she picked

and she can land at zero speed instead of from 40 to 70 m.p.h.—the speed of an express train.

Experience has shown that aeroplane services cannot pay their way and must be subsidised,[1] and air advocates now affirm that "it is to the airship that we must look for the development of paying commercial routes."[2]

Apart from the proposed use of airships as passenger and freight carriers their utilisation as *war vessels* is confidently foretold. Commander Burney states:

> "The airships necessary in time of war would be provided in the first place by the development of the commercial vessel. Experience showed that, if any type or class of vessel was to be of use in war-time, there must be an equivalent class[3] for commercial use in peace services from which the requisite number could be drawn in case of emergency," and that "from the standpoint of the Navy, airships should be regarded solely from the aspect of their utilisation as *long-distance reconnaissance vessels.* The necessity for reconnaissance had been vastly increased since the war owing to there having been an entire re-orientation of world naval power, and the potentiality of the airship as the cheapest known alternative to the light cruiser had only to be examined to ensure its adoption by the leading navies of the world. To-day the Pacific Ocean was the centre of naval importance, and the surface of

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up the Corton light-vessel between Yarmouth and Lowestoft. At 7 a.m. she came back to the aerodrome, but once more met fog, and again had the same experience at 9 a.m. It was not until 10.20 a.m. that conditions improved, and at 11.22 the main mooring cable was dropped." (*The Times*, 8. 4. 1925.)

[1] *Vide* p. 141.

[2] *Airways*, May, 1925.

[3] The meaning of Commander Burney's statement is not clear, for experience shows that efficient and proper fighting vessels have no counterpart in commerce. This, indeed, accounts for the inevitable burden of armaments which are useless for peace purposes.

the waters to be patrolled in the Pacific was about three times the size of the Atlantic Ocean."[1]

Regarding the utilisation of airships as long-distance reconnaissance vessels, it is of interest and significance to note that the R.34 did not sight a single vessel in the open Atlantic[2] on her voyage to America, and on her return journey, one only:

> *3rd July.*—"We speak s.s. *Hellig Olav* bound for Copenhagen. She gives her position . . . wish we could see her instead of only talking to her."
>
> *4th July.*—"Another big iceberg can just be seen in the dim distance. These are the only objects of any kind, sort, or description we have yet observed on this journey."
>
> 10*th July.*—"A five-masted schooner under full sail on starboard beam about five miles away—the first ship we have yet seen in the open Atlantic on either outward or return journeys . . . we are now over the main east-bound summer route of steamers from New York to Queenstown, so perhaps we may meet an out-bound liner. The s.s. *Adriatic*, due New York on 13th, should be somewhere near us, and we are on the look-out for her on our wireless."
>
> 12*th July.*—"We are on the 5,000-foot level, with a perfectly clear blue sky and deep blue sea; visibility is at its maximum, and at this height, according to our textbooks, we should be able to see a distance of 80 miles from right forward to right aft, yet—although this area of visibility works out at 19,200 square miles—not a ship is in sight. I am afraid that my ambition to see a steamer at close

[1] *The Times*, 14. 5. 1925. The Americans found it necessary to provide a mobile mooring mast for airships at sea, and over the wide waters of the Pacific the need for mooring masts would seem to be imperative.

[2] "Log of H.M.A. R.34," pp. 38, 58, 107, 123.

quarters in this gigantic Atlantic will never be realised. If it wasn't for the fact that we have been actually speaking to them all the way across, I should feel inclined to say there are none in the Atlantic at all."

Experience in the War demonstrated how disappointing, futile, and misleading, airship reconnaissance proved. On 24th April, 1916, the scouting Zeppelins in the North Sea gave no information of Beatty's approach, though he was only 50 miles off Admiral Hipper's Squadron, and on the authority of Admiral Scheer, "German airship reconnaissance on 31st May, 1916—Battle of Jutland—was a failure."

"This failure to give any information to the German Commander-in-Chief came from two causes: first, the fact that weather conditions remained so unfavourable that the airships were unable to leave until they were many hours too late; secondly, because the conditions of low clouds and atmospheric visibility made observation impossible. Even the one airship that passed over the battlefield did not see or hear anything of the battle."[1]

Admiral Scheer's plans for 23rd May to 1st June, 1916, had included special aerial reconnaissance of the North Sea:

"Provision was made for the largest possible number of our [German] airships to assist the enterprise by reconnaissance from the air, but, as the weather each day continued to be unfavourable, the airship commander could only report that it was impossible to send up any airships."[2]

"Between 2 and 4 p.m., 31st May (1916), five ascended for the purpose of long-distance reconnaissance in the sector between north and west from

[1] Quoted in "Naval History of the World War," p. 155, Thos. G. Frothingham, Capt. U.S.R.

[2] *Ibid.*, p. 153.

Heligoland. They did not succeed in taking any part in the action which developed soon afterwards, nor did they hear anything of the engagement."[1]

German airship reconnaissance did not prove any more reliable or effective on its next trial.

On 18th August, eleven weeks after the Battle of Jutland, Admiral Scheer made "another sortie into the North Sea, aided by an elaborate scouting system, the result of his experience in that action." Admiral Scheer's new plan was to "advance against the British coast behind a screen of submarines and Zeppelins. Four Zeppelins (L.22, L.24, L.32, L.30) were ordered to patrol between Peterhead and Christiansand; three more airships (L.31, L.11, and L.21) were posted off the British coast between Newcastle and Hull; and another (L.13) was stationed in the Flanders Bight. These airships were intended to serve as a kind of long-distance cover to give warning of the approach of the British Fleet. Before the Battle of Jutland, on 31st May, his reconnaissance system had quite failed to warn him that the British Fleet was approaching, and he had, in consequence, joined battle at a hopeless tactical disadvantage. His new and elaborate system of airship and submarine outposts was devised to give him better and more timely news of British movements. He was prepared to give battle again, but only on his own terms."

"The German Fleet sailed at eight o'clock on the evening of 18th August. The Admiralty evidently realised that something was impending, and ordered the Grand Fleet to put to sea during the afternoon of the 18th," and "the British Fleet must have passed the northern cordon of Zeppelins during the dark hours, for Admiral Scheer received no reports from them. It was upon this line of airships that he depended for news that the Grand Fleet had left harbour." The day dawned on the 19th, and in due course "Admiral Scheer got news

[1] Quoted in "Naval History of World War," p. 155.

from his Zeppelins that there were British forces to the north and south of him. The reports of their composition, and of the courses which they were steering, were confusing, so he did not change his plans, and held on for Sunderland." Meanwhile Admiral Jellicoe "turned south again and steamed towards his adversary. At about a quarter to two he was told by the Admiralty that the German High Seas Fleet was some 50 miles to the south of him. It seemed now only a matter of moments before the advanced forces came into contact, and both sides made their final preparations for battle." But "an extraordinary hazard of sea warfare altered the course of events, and the battle never took place. . . . Admiral Scheer received a report which made him alter his whole plan. The Commander of L.13, who had evidently been dogging Commodore Tyrwhitt in the Flanders Bight, reported that he was in contact with 'strong enemy forces of 30 units'; a few minutes later he confirmed this by a signal that these forces were made up of battleships, destroyers, and light cruisers. The Zeppelin Commander was quite mistaken." At 12.30 on 19th August, "this false report from the Zeppelin Commander confirmed his own false deductions, and Admiral Scheer at once turned the High Seas Fleet to the south-east, in chase of the phantom battleships in the Flanders Bight. He never found them, for none was there; but his turn to the south-eastward carried him out of Admiral Jellicoe's reach. . . . Admiral Scheer pressed on to the south-east until about four o'clock, and then turned for home. . . . If he ever realised that he had followed a perfect will-o'-the-wisp, he was too stubborn to admit it. He has written a long and straightforward account of the whole business, and it is from a modest entry upon one of the charts annexed to his book that we get a history of the blunder." This false report of the Commander of L.13 altered the whole course of the war at sea, and was the turning-point in the history of naval operations. "Admiral Scheer gave up all thought of making any further fleet sorties, and

every ounce of German naval energy was thrown into the new submarine campaign."[1]

Another account of this reconnaissance on 19th August, 1916, is given.[2] Admiral Scheer says that at 2.22 p.m. he began to receive reports of British Naval forces from one of the airships (L.13), but "at 3.50 p.m. the L.13 reported that it had lost touch with these British forces because it had been forced to turn aside from its course to avoid thunderstorms. Unfortunately the airship failed to get into touch with them again."

These are the recorded experiences of airship observation in peace and reconnaissance in war, yet Lord Thomson, our late Air Minister, in urging air schemes, says that persistence in airship development is justified on many grounds. "For naval reconnaissance an airship is faster than any cruiser; its range of vision is far wider, and consequently for scouting purposes its value would be considerable."[3]

It has been made plain and very clearly demonstrated by experience that an airship over the high seas or oceans cannot be sure of her own position[4] unless she speaks a friendly vessel:[5] should she sight an enemy vessel she

[1] The Naval Correspondent to *The Times*, 19. 8. 1926.

[2] Quoted by Capt. Frothingham in "Naval History of the World War," p. 291.

[3] The *Sunday Times*, 14. 3. 1926. After the experiences of the War, the Navy is unlikely to hold any brief for reconnaissance by airship.

[4] A helmsman who took part in Zeppelin raids over England says: "Those of us who steered the airships over England had every opportunity of judging how uncertain were our commanders as to their course, and the effect of our bombs. Many a time I had heard them wondering were they over England! As I was at the wheel I knew as well as they did of their uncertainty." (*J. of the R.U.S.I.*, February, 1926, p. 107.)

[5] Information by wireless being broadcast is therefore non-secret, and though messages be coded, the presence of the transmitter is known and if directional is fitted, its position will be disclosed (*cf.* p. 172, para. 3). In war a friendly vessel could only help the airship by risking the betrayal of her own presence and position to the enemy. It would appear that just so far as directional wire-

will clearly get no helpful information. Her own position being unknown to her, any report as to the position of the hostile vessel cannot be accurate, and an inaccurate report is of little value and may be worse than no report at all. Added to these disabilities is the curious variation of the power to sight objects on the sea from the air which makes aerial observation most unreliable.

In addition to the proposed employment of airships as reconnaissance vessels, Commander Burney conceives their value as *actual fighting ships* :

> "The bomb- and torpedo-carrying airship would be subsequently evolved, but it would be many years before the various problems connected with a development of this character could be satisfactorily solved."[1]

But still further utilisation of the airship in time of war is contemplated. Sir Samuel Hoare, Secretary of State for Air, says:

> "It is my firm conviction that airships will during the next generation play a great part in the development of Empire defence and Empire communications. Of Empire defence, I need only say that the introduction of airships as aeroplane and troop carriers may in the future revolutionise many established ideas. Of airships as a means of improving Empire communications, let me remind you that England and India are 5,600 miles apart, and that the normal journey of fifteen days by steamship can be reduced to four or five days by airship, and that the 14,000 miles journey from England to New Zealand can be reduced from fifty-one to fourteen days. . . . When these developments take place,

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less is dependable and efficient in peace, its use in war would be highly dangerous, inimical to concealment, rendering reconnaissance on the part of the enemy fleet largely unnecessary.

[1] *The Times*, 14, 5. 1925.

and take place they certainly will," Sir Samuel Hoare envisages the penetration "with British machines, whether they be airships or aeroplanes, into the uttermost corners of the air."[1]

At a later date Sir Samuel Hoare reaffirmed the necessity of airships for providing mobility to aeroplanes, and on the authority of his experts is convinced of their practicability. They are in his opinion complementary and necessary to each other:

> "They might say that during the War the airship proved itself vulnerable to attack, and did not justify the hopes placed on it by the Germans. That might be true in the last war, but it by no means followed that it would be true in Empire emergencies in the future. It might be that although the airship was vulnerable to attack, it would be *valuable in wars of a different kind*, for the transporting of men and aeroplanes from one place to another. His technical advisers told him that there was no reason why the airship of the future should not be able to transport quite a number of aeroplanes, with their crews, quickly from these shores or from air bases, to the furthermost ends of the Empire."[2]

Lord Thomson of Cardington, Secretary of State for Air, 1924, states: "an airship is, of course, very vulnerable to air attack, but if it should prove possible to utilise airships as aircraft carriers, they will be capable of self-defence against a limited number of hostile airplanes. The next few years will prove the possibilities of airships; but, in all human probability, they will play an important part in the Air Force of the future. Their employment will not be confined to naval operations; they could be used for transporting troops."[3]

These authoritative statements of successive Secretaries of State for Air make it plain that the strategic

[1] *The Times*, 5. 6. 1925. [2] *The Times*, 15. 10. 1926.
[3] The *Sunday Times*. 14. 3. 1926.

plans of the Air Ministry include the conveyance by airship, not only of troops in time of war, but also of aeroplanes to distant fields of warfare. The Prime Minister has recently stated that "the aim of the Air Ministry was to produce airships to meet the requirements of all three Services, as aircraft carriers and for the conveyance of troops, as well as for naval purposes."[1]

The use of the aeroplane as a primary weapon in regions beyond the limit of its own unaided flight necessitates quick transport, and moreover, the enormous wastage[2] of aeroplanes in war requires that the transport facilities should be abundant. We are asked to look to airships for this rapid and efficient transport for, if aeroplanes indeed constitute the primary and main force in future wars, any failure in supply of these craft must bring about defeat.

This necessity for the quick conveyance and mobility of aeroplanes is further developed by Sir Hugh Trenchard, speaking at Cambridge University on the 29th April, 1925:

> "Dealing with the air defence of the Empire," he declared "that this Empire alone was peculiarly situated for the employment of the air to the maximum; aerodromes suitably arranged and built, even if they cost a few millions, would save expenditure . . . so long as they had the ground organisation the actual air unit became very mobile, and would become a thousand times more mobile *when the great aircraft carriers of the future—the airships—came into being.*"[3]

Referring to airships as aeroplane and troop carriers their vulnerability in such circumstances is very apparent,

[1] *Parl. Debs.*, 11. 3. 1926. On the 22nd April, 1926, the Financial Secretary of the War Office, in reply to a question, said: "It would be premature at this stage of airship development to express any definite opinion on their utility for the transport of troops." This is the guarded reply of the War Office.

[2] *Vide* pp. 196-197.

[3] *The Times*, 30. 4. 1925.

and the question of arming them should be considered were it not that such utilisation is totally impracticable, since the combined weight of troops and war material, or of aeroplanes, pilots and gunners and ground personnel (say, fifty per aeroplane),[1] in addition to the weight of the airship and her crew, necessary ballast, fuel, and food, and the provision of guns for the airship's own defence, is governed and very strictly limited by the lifting power of hydrogen or helium gas.

It has been shown that an airship undertaking transport on a long non-stop flight,[2] allowing for some margin of fuel, would have a negligible useful lift even if filled with hydrogen gas; but hydrogen is a dangerous gas, especially in war,[3] and this alone would render the ship vulnerable to incendiary bullets. Apart from the ordinary factors reducing lift,[4] special cognisance must be taken of the reduction in lift in tropical regions. The already negligible useful lift does not allow for any guns for the airship's own protection nor any scope for rising to a reasonably safe flying height,[5] and the ship must keep

[1] *Vide* p. 195, note 2.

[2] The useful load that can be carried on any voyage by an airship depends upon the length of the voyage (for this determines the weight of fuel which must be taken), and on the height at which the airship desires or is obliged to fly.

[3] The German helmsman (of the L.45), speaking of German airships and incendiary bullets, refers to the inflammable gas as "the terrible hydrogen."

[4] *Vide* p. 39.

[5] Describing the later Zeppelins built after the early war experiences the helmsman of the L.45 says: "Everything was so perfectly contrived to save weight, while the ship was even bigger, though it had grown lighter and so rose higher. The cars were smaller, it is true; we were more crowded; our rest quarters had been suppressed; machine-guns had gone so as to reduce all weight. Height and speed, we were told, would be our true defence. Six thousand metres (about 20,000 feet) would be easily attained, and no English gun or aeroplane, it was stated by our officers, could touch us at that height. Alas! our hopes were not to be fulfilled so literally as that. . . . Navigation, too, grew more difficult at such heights." (*J. of the R.U.S.I.*, February, 1926, p. 109; *vide* also p. 91, note 1.)

low until she has expended fuel. If the airship must fly high to be beyond the reach of anti-aircraft guns (10,000 to 25,000 feet or more) she cannot carry any load, nor carry fuel for any long distance, for at 2,500 feet the static lift of such a ship is reduced by nearly 12 tons, at 4,000 feet by nearly 18 tons, and at 10,000 feet by 40 tons.[1] Moreover, the speed of the ship would be considerably reduced if such parasitic obstructions as aeroplanes were carried. The airship experts at Lakehurst, U.S.A., worked out the proposition of airships as aircraft carriers, and they found "that if the 5,000,000 cubic feet airship could get an aeroplane up inside of her so as not to impede her progress by hanging in the streamline, she could carry one plane to a point within 250 miles of New York, and that plane could carry one 1,000-lb. bomb, and that was all she could carry" if she were to get back to the dirigible and be taken back to Europe. "That was worked out only on a question of endurance," and does not take into consideration any other difficulty.[2]

It becomes self-evident that the negligible carrying power of airships renders them useless for the transport of aeroplanes, apart altogether from the fact that they are unreliable and dangerous.

It may be thought that aeroplanes can reach a distant scene of operations under their own power. They clearly must not rely upon landing grounds on foreign territory, and an All-Red Route is a necessity. From this country to the East or to the West large stretches of ocean must be covered, and landing-places established. Indeed, a scheme has been prepared by Mr. L. Blin Desbleds, and the delegates to the Imperial Conference held in London (October, 1926) were furnished with full details and plans of his project for providing man-made islands of concrete floating in mid-ocean.[3] "These float-

[1] *Vide* p. 89, para. 1. [2] "Hearings," pp. 1029, 1030.

[3] The *Daily Express*, 28.10.1926, and the *Sunday Times*, 7.11.1926.

ing islands would be the links in a genuine 'All-Red' air route through the Empire." It is proposed that these islands with their hotels, lighthouses, and power plants of enormous Diesel engines, should be "defended by aircraft, anti-aircraft batteries and torpedoes, and by such other means as the military, naval, and air authorities devise," a very necessary precaution against possible enemies in the proximity. Extravagant and laughable as this project appears, it has at least the merit of being logical, for some such aid to air power in distant fields of warfare is essential unless sea-borne transport of aircraft is frankly faced.

The size and number of aircraft carriers are strictly limited by Treaty; moreover, these carriers are intended for operations other than the provision of mobility to shore-based aeroplanes, and they are unable, even if prepared, to supply the rapid transport for the innumerable aeroplanes required for air warfare. There only remains transport by steamship, therefore the use of aeroplanes in regions beyond their own powers of flight must be limited to the number that can be transported as freight. But aircraft and air service supplies are the most bulky of cargoes, a bombing plane requiring more than 160 ship tons of space and a pursuit plane over 21. The Americans have estimated that it would require fifty ships (dead weight tonnage 6,970 each) to transport 403 bombing planes and 800 pursuit planes; yet these ships would not provide for carrying the personnel required (pilots and ground force), the fuel and spares, or the bombs—all of which are manifestly essential.[1] Since the planes must be packed in crates for reassembling in the distant war zone, vital considerations arise of time, of skilled mechanics, and of the situation and defence of the proposed reassembling bases.

The experience of reassembling American aeroplanes in France was related at the Hearings of the Morrow Commission. Brigadier-General Connor stated that three

[1] "Hearings," p. 1532.

Construction Squadrons arrived at Romorantin, the selected assembly base, on 15th January, 1918. On 11th May the first plane was received, and it was forwarded to the Front on 29th May. Up to 11th November, 1918, the total number of new planes received was about 1,200, and the number assembled and forwarded to units and flying fields was 1,087. All the planes were forwarded under their own power, and 5 per cent. of them crashed *en route*. In November, 1918, the personnel of this assembling and repair station amounted to 334 officers, 9,200 men, 1,175 Chinese, and 552 male and female employees; in all, a personnel of 10,261 for unpacking and reassembling only.

It is clear that for Empire defence the mobility of aeroplanes is a myth, and that the strategic schemes of the Air Ministry require review.

The great effort and outlay required to convey aeroplanes beyond a neighbouring sphere of action draws attention to their value as weapons of war. Remarkable statements have been made about the 'power of the air,'[1] and the belief is widely held that "the old order of things is doomed already, and the day of contentions of great armies . . . is passing away before our eyes." It is affirmed that:

> "Now for the first time in history it has become possible to dispense with the preliminary stages. Air power can strike straight at the heart of the enemy State. It can ignore armies and fleets."
>
> "It will cut out certain stages in the older methods of approach to the real end of the war, the imposing of one nation's will upon another. In its power of 'direct action' it will see a means, and an effective one,[2] of attaining that end without resorting to the slow, costly, ineffective, murderous procedure of conducting a campaign or bringing a hostile fleet to action."

1 "Air Power and War Rights," J. M. Spaight, pp. 2-5.

2 *Cf.* the effectiveness of sea-power, p. 231.

> Air forces "will set themselves to break the *moral* of the people. Their task will be, in fact, to create a 'complex of defeatism' in the national mind of the enemy."

It is clear from his speech at Cambridge that Sir Hugh Trenchard, the Air Chief Marshal, agrees with this forecast of air power, for he stated that "the aeroplane was the most offensive weapon that had ever been invented," that "nothing else could finish a war so quickly as lowering the *moral* of the enemy" by an active aeroplane offensive, and that the result of a war would be determined by the number of aeroplanes on each side at the start and the rate at which they could be replaced.

Since this speech we have had wars to hand.[1] France has been engaged in Morocco, a mountainous country near her doors, and in Syria, a desert region some 2,000 miles away. France has the largest Air Force in the world; her enemies—Mohammedan tribes—were unequipped with latter-day weapons and the paraphernalia of mechanicalisation; yet these proud and independent people, skilled in the art of war and with a knowledge of its first principles, have taught great Christian nations a lesson they would do well to ponder.

"Weapons may change—they have been changing since the beginnings of war—and these changes have required changes in the applied tactics of battle, but the fundamental principles of tactics and of strategy remain the same now as they have always been."[2]

Major-General John L. Hines, Chief of Staff, U.S. Army, affirms that "wars, whether on land or sea, will be won in the future, as they have been in the past, by the comparatively slow but irresistible force which is able to move from one strategic position to another—take it, hold

[1] These campaigns are examined in a subsequent chapter.

[2] "Naval Aviation," p. 106. "This truth stands to-day as a warning to those in the Services who may become prejudiced by the strength of their enthusiasm for some one means of waging war." ("Naval History of the World War," p. 307.)

it, and move on to the next. On land, this force is the Infantry; on sea, it is the battleship. An Air Force cannot do this. Aircraft will always be limited as to their radius of action. They will always be dependent on favourable weather conditions. They will always require land or sea forces for the protection of their bases,"[1] for "just as long as the air ports cannot be anchored in the clouds, their protection must be entrusted either to the Army or the Navy."[2]

General Pershing, speaking of the Air Arm, states in his farewell report: "We are logically forced back to the conclusion that armies must still fight our battles, and to win must overcome the opposing forces. The infantry still remains the backbone of the attack,[3] and the rôle of other arms is to help it reach the enemy. All must work in co-operation to that end. The idea that the principles of warfare have changed, and that armed contests will be settled in any other way, has nothing substantial in our experience to warrant serious consideration."[4]

"Since the beginning of history man has over-estimated his newest accomplishment. This has been particularly true of the means of making war."

[1] "Hearings," p. 17. [2] *Ibid.*, p. 174.

[3] Major-General Sir F. Maurice has emphasised in his book "The Last Four Months" that infantry is "the essential arm whether for offence or defence" (p. 21).

[4] "Hearings," p. 25.

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"*Good sense, which only is the gift of Heaven,*
And though no science, fairly worth the seven."

POPE.

CHAPTER VIII

RESPONSIBILITY FOR THE AIRWORTHINESS OF OUR NEW GIANT AIRSHIPS

ON the 3rd September, 1925, the *Shenandoah*[1] was completely wrecked over Ohio, with the loss of her Commanding Officer and thirteen of her crew. The disaster was reported to have occurred in a " line squall " due to electrical disturbance, and an enquiry was held into the causes of the destruction of this airship, which was considered to be the strongest rigid airship ever built.[2]

Commander C. D. Burney, referring to this calamity,[3] declared " that he has not lost faith in the future of the big airship ":

> " I most deeply deplore the catastrophe, but at the same time we must remember that these occurrences are inevitable as things are at present. Like all other things, the perfect airship must have its birth pangs. . . . We have realised that the existing ships are not strong enough, and we have taken good care that for our Empire airway routes we shall have dirigibles of twice the present strength now obtainable . . . what had to be done was to . . . let the scientists work away at their designs and formulæ. I am confident that before long they will succeed in providing a large and perfectly safe airship."

This statement is involved and ambiguous (in so far as it concerns the new giant airships), and Commander Burney's position in regard to airships in general, and to the design of R.100 in particular,[4] is not clear. Referring to his article " Airships and Empire," which appeared

[1] The greater part of the chapters dealing with airships was written before September, 1925, and therefore little reference has been made in the text to the disaster to the *Shenandoah*.

[2] *Army and Navy Journal* (U.S.A.), 31.10.1925, p. 217.

[3] *Evening Standard*, 4. 9. 1925; *Daily Graphic*, 5. 9. 1925.

[4] *Vide* p. 10, para. 3, and pp. 75 and 76.

in *Airways*, May, 1925, it is stated that Commander Burney—

> "is well known in connection with airship research, is at present engaged in the design of the giant airship R.100 which is being built by a private Company for long-distance air services. The 'Burney' airship, for which a special floating mooring mast has been designed, is to be an entirely new type, the crew and passengers being accommodated in the actual body of the ship."

The project of a subsidised service to the East was determined upon before sufficient consideration had been given to the problem as to whether a reliable and safe airship of any practical value could be constructed at all, and it would appear, from Commander Burney's remarks quoted above, that he is *now* relying upon the 'scientists' to make the 'Burney ship' airworthy.

But the 'scientists' are not satisfied only to "work away at their designs and formulæ." Mr. Frazer of the National Physical Laboratory says:[1]

> "A matter of first concern to the designer is the factor of safety of his proposed structure. He is pre-eminently anxious to obtain *some notion* of the maximum stresses his airship is likely to incur under the severest conditions of flight. . . . The precise manœuvres which may be considered legitimate in the pursuit of experimental records of this case remain a nice matter for debate. It is, for instance, questionable whether rapid reversals of helm carried out in good weather would promote such severe stresses as those attending normal navigation in really bad weather. . . . The real point at issue is whether the impulsive stresses due to violent gusts, such as were encountered by Airship R.34 at certain stages of its pioneer trans-Atlantic voyage, could

[1] *J. of the R. Ae. S.*, September, 1925.

ever be reproduced in any comparable degree by artificial manœuvres in good weather. In the writer's opinion a series of tests made at intervals during a typical trans-continental flight would provide more valuable information than would drastic experiments conducted on a short fair-weather flight."

As a matter of fact, since the R.33 has been reconditioned for experimental full-scale tests she has not undertaken any long flights, and on no occasion does she appear to have been out when clouds or weather reports presaged unstable conditions, vertical movements of the atmosphere or thunder, nor when the wind has been such as to make her emergence from her hangar a matter of difficulty or danger.

Apart from the differences in the actual design and construction of the hulls, new and differing types of engines were proposed for the two new giant airships. Instead of the usual petrol type Commander Burney intended to use in the R.100 a Ricardo hydrogen-kerosene engine, on which experiments have been made.[1] For the R.101 an engine on the Diesel or semi-Diesel principle is sought after, and endeavours are being made on behalf of the Government to produce a suitable engine of this type. Little is known of the advance that has been made in this direction, and details do not appear to have been published of the reduction in weight of the engine; great advance is clearly essential if, as is stated by Mr. Wallis,[2] a weight of 120 lbs. per brake horse-power would not be considered heavy for a reliable type of Diesel commercial engine.

In the hydrogen-kerosene engine, hydrogen is used as fuel with kerosene, and both gas and oil fuel are

[1] The Air Ministry state that it is not anticipated that this type of engine will be developed in time for the trials of the new airships, but it is hoped that the "heavy oil engines will be available for both airships."

[2] "Some Technical Aspects of the Commercial Airship," Mr. B. N. Wallis, B.Sc. (The *Engineer*, 19. 2. 1926.)

expended. When this type is employed in an airship, the consumption of fuel makes the ship lighter; on the other hand, the consumption of hydrogen taken from her gas-bags reduces her lift, but not to such an extent as to balance the weight of fuel used; the airship therefore gets lighter and tends to rise continuously. One of the advantages claimed for this type of engine over the ordinary petrol engine is that, owing to the utilisation of hydrogen as fuel, less oil fuel need be carried for any given distance, the presumption being that more freight —paying load—can be carried.

With an ordinary petrol engine the tendency of the airship to get lighter and to rise as fuel is consumed can be checked by the use of water recovery apparatus. This apparatus is similar to an ordinary condenser, and is used for replacing weight of expended fuel by water recovered from the exhaust gases: 75 per cent. of the weight of the fuel expended can in practice be replaced as water. The consumption of petrol makes the ship lighter, the water recovered tends to make the ship heavier, but not to such an extent as to balance the weight used. The airship therefore gets lighter and tends to rise continuously and to almost exactly the same extent as with the hydrogen-kerosene system.

It is true that the weight of fuel for a given distance is greater for the petrol engine than for the hydrogen-kerosene engine;[1] against this, however, must be set the much greater weight of the hydrogen-kerosene engine for the same horse-power—it is, in fact, approximately double the weight of the petrol engine with water recovery apparatus.[2] Moreover, by the use of this apparatus more than the regulation quantity of ballast can be recovered,

[1] The figures as given by Mr. Wallis are: 0·38 lb. kerosene +0·024 lb. hydrogen per h.p. hour in the hydrogen-kerosene engine: 0·5 lb. petrol in the ordinary engine.

[2] Hydrogen-kerosene engine weighs 5 lbs. per h.p. The petrol engine weighs 2 lbs. per h.p. (*Engineer*, 19. 2. 26), and the water recovery apparatus increases the weight of the petrol engine approxi-

and it need not therefore be taken aboard at the start; thus the useful lift—paying load—is appreciably increased, and may more than counterbalance the apparent advantage of the lesser weight of fuel required for the hydrogen-kerosene type, since estimated revenue from freight[1] is enormously greater than the cost of the extra fuel.

With regard to the operational aspects of these two systems, it has been shown that in both cases the tendency to rise is materially reduced to an almost equal extent, though in neither case is it eliminated. In the hydrogen-kerosene engine the effect is produced by the exhaustion of gas which cannot be replaced; in the case of the petrol engine fitted with 'water recovery,' it is produced by the recovery of weight which can be discharged at will. The petrol engine with water recovery plant, while making a reserve of ballast, only gives up precious gas when it must—when forced to rise above pressure height or to descend on even keel, and on landing.

The characteristics and relative efficiencies of the three systems have been discussed, and advantage appears to lie on balance with the petrol and water recovery plant.[2] The points of advantage and disadvantage are insignificant however when the inherent disabilities of airships are considered. But as a matter of fact, the hydrogen-kerosene engine will not be installed in the 'Burney ship,' and the Diesel type of airship engine is still in an experimental stage.

It is not clear how far the Air Ministry is approving

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mately to half the weight of the hydrogen-kerosene type. Commander Burney has stated that the R.100 will have a capacity of 5,000 h.p.: at 5 lbs. per h.p. the engines would weigh over 11 tons.

[1] *Vide* p. 40.

[2] The Americans and our own Air Ministry favour water recovery, while in the opinion of Mr. Wallis (a protagonist of the hydrogen-kerosene engine and associated with Commander Burney in the construction of R. 100) water recovery is accompanied by certain grave and dangerous disadvantages. (The *Engineer*, 19. 2. 26.)

of the design and of the new features proposed in the 'Burney ship,' R.100; or, indeed, who is ultimately to be held answerable for the airworthiness of this great airship. As regards the R.101 which is being constructed at the Royal Airship Works, Cardington, the Air Ministry itself takes the entire responsibility for its initiation, design, and construction, for according to a statement made by the Prime Minister,[1] the Admiralty has not been consulted on the construction of either this airship or the 'Burney ship.'

But the handing over of airships to the Navy is foreshadowed.[2] *Flight*, the organ of the Royal Aero Club, and closely associated with the Flying Service, says:

> "nor are we at all sure that there would be much harm in handing airships over to the Navy, although by its earlier attitude towards 'gas bags' the Navy has done little to deserve being put in charge, but the design, construction, and operation of airships are so much more parallel with maritime problems than heavier-than-air craft, that a very good case could be made out."[3]

While airships are heralded in the public Press, and such comments and suggestions are made, the Navy, true to her tradition, remains silent.

[1] In reply to a question by Commander Bellairs (*Parl. Debs.*, 11. 3. 26).

[2] *Flight*, 7. 1. 1926.

[3] Referring to the new Airship Club, it says: "Why not let the Senior Service come forward and help the scheme through its initial stages? If airships are ultimately to be handed over to the Navy, this step would seem to be a logical one." The Royal Aero Club claims to have "initiated" the Air as a separate service, and to have cried the slogan "One service, one uniform, one badge."

"*A rotten case abides no handling.*"—SHAKESPEARE.

"*When a man's knowledge is not in order, the more of it he has, the greater will be his confusion.*"—HERBERT SPENCER.

CHAPTER IX

AIRSHIPS CONCLUDED

THOSE readers who have had the patience to follow the argument developed in the preceding chapters can hardly fail to have noticed the absence of any direct expression of opinion on the part of the writer.

Facts—plain and incontrovertible—have been stated; obvious and inevitable conclusions have been deduced from these facts, and free quotations have been made of the varying opinions of Ministers, Navigators, Meteorologists, Scientists, Physicists, Constructional Engineers, Panels and Commissions, and of those concerned in the use and engaged in one way or another with the construction or operation of aircraft.

This survey of airships represents the author's study of facts, and of the opinions of those various authorities who *in no case* are antagonistic to the 'Air.' It may now be of interest to examine the varied and opposing opinions of the lighter-than-air and heavier-than-air schools on the value and use of airships for military and commercial purposes.

Major Oliver Stewart in his recent book[1] says:

> "Air war is now the essential preliminary to all other war. . . . In war complete air supremacy is victory. The heart of a nation at war is the towns and villages . . . where live and work the civilian population. The aeroplane can reach these towns and villages, and it can spread destruction and terror until the will to fight is broken. . . . The bombing branch alone of the aerial arm possesses tremendous striking power, a power which is but faintly imagined even by those who experienced what may be called the preliminary experimental bombing of the last war," etc., etc.

[1] "The Strategy and Tactics of Air Fighting," by Major Oliver Stewart, M.C., A.F.C.

Major Stewart has no belief, however, in the military value of airships, and has much to say about their futility as war weapons:

> "Airships will be forced to keep far from the chief scenes" of action. "They are not able to fly over or to exist near any scene of operations. They are not vessels of war. They could be broken up very easily, and the fuel tanks could be set on fire even if the tanks contained heavy oil."[1]

He adds:

> "Officially there is a strong bias in favour of airships as instruments of war," but those who claim that the carrying of aeroplanes in slings is "a protective device for airships, accuse themselves of ignorance of air fighting. . . .
>
> "It is remarkable that it has been possible to foist such an impression upon so large a number of people," but "lest these views be suspected of being prejudiced, I must say that I believe that airships may have a great value for some kinds of commercial air transport."

Major Robertson (reviewing Major Stewart's book)[2] disagrees entirely with his view of the uselessness of airships in war. In his opinion "their sphere is to be the patrolling of the great ocean trade routes, to look out for raiders like the *Emden*, leaving it to the Navy to arrange for the destruction of the raiders once they have been located."

But Mr. Handley Page has no belief in the future of

[1] "According to a technical report issued by a Government experimental department heavy oil is, in many circumstances, more readily set on fire than petrol." ("Strategy and Tactics of Air Fighting," p. 131.)

[2] Major F. A. de V. Robertson, in *Flight*, 10. 12. 1925 and 21. 1. 1926.

the British Navy. Discussing the proposed reduction of the Air Vote, he said:

> "We were no longer an island, but we were spending millions on our Navy and Army which were completely obsolete. It was a fact; they were no use at all when they could be bombed by aircraft."[1]

Lieut.-Colonel Lockwood Marsh, C.B.E., A.F.R.Ae.S., late R.A.F., in a lecture at Sheffield on "The Evolution of Flying and its Future," asserts on the other hand that:

> "A good deal of nonsense was talked about the military side of flying. The Air Force would not make either the Army or the Navy obsolete. He was not sure even that it had altered in any way the principles of warfare. It had simply introduced a new element[2] and a new weapon. He did not believe in the bogey of attack by gas-bombs from the air. At sea he believed the aircraft carrier would disappear because of its vulnerability," but an airship would be useful in war, it "would patrol the commercial routes, carrying torpedo-carrying aircraft and fighting scouts for its own protection, and would also accompany the Fleet for reconnaissance duties."[3]

Commander Sir A. Trevor Dawson, Bart., R.N. (Retired), Vice-Chairman of Vickers, Ltd., and Chairman of the Airship Guarantee Company, believes that the technical feasibility of cross-ocean airship voyages has been demonstrated, and "only development in size and

[1] *Flight*, 28. 1. 1926.

[2] The air can scarcely be called a new element even in warfare; except for under-sea craft the air has always been the medium through which projectiles have been propelled, be they arrows, shot or shell. When submarines, to fire their projectiles, first took to their element—the waters under the sea—the ocean was not considered a new element.

[3] *The Times*, 21. 9. 1925.

power is now required." In his opinion great commercial airships can be readily converted into vessels for war purposes, and the experience gained in the operation of commercial craft will be of the greatest possible value in advancing design and keeping and training crews who would be available in time of war.[1]

As regards commercial uses, Lieut.-Colonel Lockwood Marsh expresses doubts as—

> "to the aeroplane having any great future where railway communications were good . . . they would come to the airship,[2] which would develop into craft carrying 150 to 200 passengers . . . making non-stop journeys eventually to Australia, at a speed of 100 m.p.h. They would carry aeroplanes by which passengers could be landed at intermediate points, and by means of which new passengers could arrive while the airship continued on its non-stop journey."

The Secretary of State for Air, Sir Samuel Hoare,[3] says:

> "For long-distance journeys airships are probably the most suitable craft. Flying in an aeroplane for more than a few hours soon becomes tiring, and it is to the airship I look for the long-distance passenger-carrier of the future."

Sir Alan Cobham at Rangoon stated his belief, as a result of experience in his great Australian flight, that the establishment of an air service between Great Britain and Australia will be effected by airships and not by aeroplanes,[4] and the Editor of *Airways* states that:

> "Although at present there is not one commercial airship in existence in the world, there is never-

1 "Commercial Airships," from Introduction by Sir Trevor Dawson.
2 *Cf.* p. 97.
3 *Airways* (Special Interview), May 1926.
4 *The Times*, 20. 9. 1926; *Times* Leader, 2. 10. 1926.

theless a large body of opinion that the future of aviation lies in the airship rather than in the aeroplane."[1]

A diametrically opposite opinion is expressed by Lieut.-Commander the Hon. J. M. Kenworthy, R.N., M.P. Discussing the disaster to the *Shenandoah*, he says:

> "the reports tend to show that the disaster was one inherent to airships themselves, however great the improvement made in them, and however skilled the navigators and crew. In fact, the larger airships become, the more vulnerable they are, not only to opposing heavier-than-air craft in war, but to the elements,"[2]

and he enlarges upon the vulnerability of airships, the enormous expense of air bases which "really render airships impracticable both for war and for commercial purposes," and upon the "vested interests" that "are concerned in the construction of these bulky and already obsolete engines of war and peace."

The most authoritative statement, however, on the value and use of airships for military purposes, was given by the Air Chief Marshal, Sir Hugh Trenchard, when speaking at Cambridge on the air defence of the Empire. As has been already quoted,[3] he said that this Empire was peculiarly situated for the employment of the air to the maximum, and that the actual air unit would become a thousand times more mobile when airships, the great aircraft carriers of the future, came into being. Moreover, in his opinion—

> "though, no doubt, the Navy had a great part to play . . . it seemed to him that in another 50 or 100 years the British Empire would have to be

[1] *Airways*, October, 1926. [2] The *Nation*, 26. 9. 1925

[3] *Vide* pp. 105-107.

defended by air as the only practical method of doing it on an economical and efficient basis."[1]

Lord Thomson of Cardington agrees with these views of the Air Chief Marshal, for he states: "The development of airships may make it possible to reduce naval expenditure by the substitution of air cruisers for the far more costly surface vessels now protecting our trade routes."[2]

It is obvious however that the only way aircraft can function is by having elaborate ground facilities, and in order to have such elaborate ground facilities there must be a surface Navy and a surface Army. The protection of the Navy would be required for the transport of aviation spirit and oil, and the greater the needs of the air, the more important it will be for the Navy to have and to hold the supremacy of the sea.

It has been shown that the overruling and dominating factor in all aerial navigation is the fact that aircraft, unlike any other means of transport, operate in one medium only, and that medium *a gas* capable of movement in any direction at speeds which may and do vary constantly, and which may attain speeds far in excess of that possible for any airship and for any but very fast aeroplanes. Meteorology may some day succeed in predicting weather conditions, but it can never control the power of the air. No research nor any effort of man can affect its translatory[3] or convulsive movements, nor can

[1] *The Times*, 30. 4. 1925. In the opinion of Rear-Admiral Strauss (U.S.A.), "the cost of aircraft defence on land and sea is simply enormous."

[2] The *Sunday Times*, 14. 3. 1926.

[3] "In the winter of 1898-99 the Meteorological Council, which directed the Meteorological Office of those days, was so much impressed with the violence of the weather reported from the Atlantic between 18th December and 15th February, that a special enquiry was ordered. A calculation disclosed that the development of the centralised system in 1899 involved, or perhaps was caused by, the removal of nearly two million million tons of air from the area between 40 degrees and 60 degrees North and between 10 degrees

the future hold any hope that the lifting power of hydrogen can be increased.

These facts alone show that airships can never be reliable, safe, or practicable, either for extended military or commercial purposes. Lack of stability, navigational disabilities, and the need of elaborate, extensive and expensive paraphernalia add to the danger, to the unreliability, and to the commercial and military impracticability of such craft, though it should be stated that for short-distance reconnaissance on selected days and from convenient shore stations, in the manner in which 'Blimps' were used in the late War, airships are feasible, but experience of the past seems to show that the cost and effort are greater far than is justified by the results obtained.

It would seem that departmental specialisation is responsible for the marked tendency at the present time to concentrate upon isolated aspects of a question to the exclusion of a broad consideration of the question as a whole. The inflated staffs resulting from this 'departmental specialisation' in our great offices of State are legacies of the war and post-war policy for which we are still continuing to pay most dearly, not mainly on account of the salaries of these enthusiastic and energetic specialists, but principally because of the expenditure involved in the development of their ideas. If a department is established for the special development of a material branch—be it aeroplanes, gas, tanks, wireless, torpedoes, or what not—the idea that such may have its limitations (and has perhaps reached, if not actually passed, the point of maximum efficiency beyond which true progress is impossible) is unlikely to be welcomed by a department charged solely with its development. If the appliance or weapon is on the other hand definitely unsound from

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and 60 degrees West. . . . The removal of so vast a mass of air from its accustomed place is a feat of engineering compared with which the construction of the Sennar Dam is a small matter; *yet the atmosphere can manage it in a few days.*" (*The Times*, 6. 2. 1926.)

inherent causes, or because its cost is far beyond its possible value, or its usefulness is dependent upon such favourable conditions that it can only be relied upon in certain definite and limited circumstances, the department concerned in its development can hardly be expected to declare that the weapon, or appliance, or machine, is in practice of little or no value; it is only human to extol its importance and power, and press for its introduction into all possible spheres, even where its use is superfluous if not positively harmful.

It seems almost unnecessary to state that in the writer's opinion all airship work at the expense of the State should cease; that constructional work on the R.100 and R.101, the building of hangars, of mooring masts and gas-producing stations, should be entirely abandoned so far as State funds are concerned, and means should be taken to recover from the wreckage of airships and their paraphernalia what little can be salved for the benefit of the Exchequer. Those who believe that airships have a great future should look to other than State funds to finance their schemes and establish their hopes. All other means of transport have been so established in the past.

"*Facts must be faced. You can avoid some of the facts all the time and all the facts some of the time, but you cannot avoid all the facts all the time.*"—MR. BALDWIN *at Norwich*, 18. 7. 1926.

CHAPTER X

CIVIL AVIATION

THERE is undoubtedly a widespread belief, the result of insistent and energetic propaganda, that the air has revolutionised many of our old ideas with regard to transport, and that airships and aeroplanes will become important carriers in the future, "uniting the Empire and bringing the countries of the world more closely together."[1]

In pursuit of this vision, the lighter-than-air school who appreciate the limitations of the aeroplane, look to the airships:[2] the heavier-than-air school scoff at airships, regarding them as monsters, vulnerable and unwieldy. Some, whether from faith or circumstances, give countenance and active support to both, and a department of the Air Ministry has been formed, the sole duty of which is the development of airships and aeroplanes for commercial purposes.

The powers and possibilities of airships have already been examined in some detail. Facts have been brought forward and evidence has been produced which undoubtedly warrant the deductions and conclusions which have been drawn.

With regard to the use and development of aeroplanes for commercial purposes, it seems quite clear that there is something amiss with the state of Civil Aviation.[3] In spite of repeated advertisement of its present value and future prospects, confidence in this new method of locomotion has not been established, and those who can afford it do not use it to any extent, or continue to use

[1] Sir Samuel Hoare, *Flight*, 6. 5. 1926. [2] *Vide* pp. 97-105.

[3] Indeed, the Director of Civil Aviation has been likened "to a doctor with excellent bedside manners, who was in attendance on Miss Aviation. If he went to see his patient and there was a little trouble, the 'doctor' never let the patient realise that there was any trouble, but cheered her up with breezy remarks." (*Flight*, 24. 12. 1925.)

it. The public have at all times been ready to invest in any new and promising venture, but faith and confidence here are lacking, and adequate support is not given to aerial means of transport; so much so, that journey by air to the Continent, only possible to and desired by a small section of the community, would have ceased to be available but for the substantial levy drawn from the whole body of taxpayers to maintain this luxury, though not luxurious, travel. Subsidies were first granted in 1921, and the Air Council's subvention to British Air Lines for the six months from 1st September, 1922, amounted to £95,000. Air lines operated as long as adequate grants were available; when these ceased the British Cross-Channel services promptly stopped. In 1924 the several companies amalgamated as Imperial Airways Limited, and obtained from the State a subsidy of £1,000,000 sterling over a period of ten years. The cost to the taxpayer of every mile flown by Imperial Airways Limited is 3s. 4½d.[1] The Air Estimates show the payments to this Company as £137,000 for the financial year 1924 (31st March, 1924, to 1st April, 1925),[2] £137,010 for 1925, and £167,000 for 1926, a total of nearly half a million in the first three years of working.[3] Furthermore, the State retains at Croydon and Lympne, presumably for traffic control and inspection, a personnel costing over £16,000 a year, and is expending in addition £315,000 on improvements to the aerodromes at these places. On the authority of the Secretary of State for Air, Imperial Airways had in 1925 "only twelve efficient machines in operation, excluding experimental machines under test for the Air Ministry."[4] According to the

[1] *Parl. Debs.*, 24. 6. 1926.

[2] According to the balance sheet of Imperial Airways Limited, this Company had received £139,409 18s. 5d. by 31st March, 1925 —a discrepancy of £2,409 18s. 5d.

[3] In spite of the enormous subsidies the balance sheets of Imperial Airways Limited show a loss of £15,217 on the first year's working and £20,414 on the second year.

[4] *Parl. Debs.*, 6. 8. 1925.

Official Report,[1] in addition to those machines still under test from the previous year, nine or ten experimental "civil types of landplanes or seaplanes have been built or are in process of design or construction to the order of the Air Ministry." One—the Handley-Page *Hamilton*—has been purchased by Imperial Airways at a price which, according to Sir Samuel Hoare, "it would not be in the public interest to disclose."[2] The co-operation and indeed the connection between Civil Aviation and the Air Ministry is extremely close, and their separate functions difficult to disentangle.[3]

Imperial Airways Limited, even with £1,000,000 subsidy, are thus not able to develop Civil Aviation without the active co-operation of the Government and further substantial help from the taxpayer. Though Mr. Winston Churchill, as Air Minister, stated in 1919 that "Civil Aviation must fly by itself," paradoxically enough, as Chancellor of the Exchequer, he appears to offer no opposition to these very substantial subventions to Civil Aviation in general and Imperial Airways in particular. Not unnaturally the great exponent of economy of the post-war days has forsaken his rôle. Sir Eric Geddes says:[4]

> "the growth of Imperial air routes must not be stunted by withholding such further Government assistance as may be necessary."

It seems therefore that the only tree to the root of which the famous 'Geddes Axe' must on no account

[1] Command Paper, No. 2707. [2] *Parl. Debs.*, 24. 11. 1926.

[3] It is stated that the largest single-engined air liner in the world, a D.H. Rolls Royce of 700 h.p., was delivered from the Air Ministry's Experimental Station at Farnborough in September, 1926, to Imperial Airways Limited, Croydon, to be used as an air tramp carrying goods from London to other capitals. (*Sunday Times*, 26. 9. 1926.) The North Sea and General Transport, Ltd., have been loaned a seaplane by the Air Ministry with which the Company will commence operations on the Khartoum-Kisumu Service until the D.H. 50 *Pelican*, which was damaged during a test flight, has been repaired. (*Flight*, 13. 1. 1927.) [4] *Sunday Times*, 26. 9. 1926.

be laid is Imperial Airways Limited, of which Company Sir Eric Geddes is Chairman.

In August, 1926, Captain Albert Lowenstein, stated to be a Belgian multi-millionaire, hired four large air expresses from Imperial Airways for his stay of several weeks at Biarritz. "The first machine which arrived has been sent to Berne to bring to Biarritz several business associates of Captain Lowenstein, and he intends to despatch machines to Brussels, Paris, Madrid, and Barcelona for others with whom he desires to confer."[1] The *Morning Post* reported:

> "Captain Lowenstein has a privately hired fleet of four huge air expresses—the fourth one went out from England on Wednesday (1st September, 1926)—with their pilots and mechanics. He is so surrounded with secretariats, transport, air, and health 'ministries' that he is virtually a State unto himself. His pilots are ready to carry passengers to any part of Europe at a moment's notice. The air transport company which owns the aeroplanes cannot, even if they were willing to do so, give information about a private charter."[2]

If four of these 'huge air expresses' can be spared during the busy season from Cross-Channel air routes, one may presume that even the trifling number of machines operated by Imperial Airways is too many for the regular traffic, unless experimental machines were used for this private and rather unusual hire.

During the Debate on the Air Estimates[3] Sir Samuel Hoare said:

> "Unfortunately it is the fact that without subsidies civil aviation would come to an end not only in this country, but in practically every other country as well."

[1] The *Daily Mail*, 26. 8. 1926. [2] The *Morning Post*, 4. 9. 1926.

[3] *Parl. Debs.*, 8. 3. 1926.

Major Hills, a late Director of Imperial Airways, affirmed that—

> "No civil plane is going through the air without a subsidy. . . . No civil aviation is paying. . . . All Governments are subsidising their civil aviation. . . . I do not think there is very much wrong with our civil flying,"

and Sir Harry Brittain stated:

> "We have a subsidised monopoly air route to the Continent, and the job is done very well indeed . . . as far as it is possible to succeed they certainly have succeeded."

It must be presumed that the Air Ministry, fully recognising the inherent expense of aerial travel, are satisfied that the utmost possible efficiency is secured and maintained by the Company operating the Cross-Channel service, since a further yearly subsidy of £93,000 for five years has been secured by the same Company for a proposed aerial service in the East from Egypt to India. "The Government is to provide aerodromes, hangars, and other accommodation along the line of flight through Baghdad, Basra, and down the shores of the Persian Gulf. The ground organisation is well advanced"—it has provided "numerous landing-grounds, refuelling stations, wireless and meteorological bases.[1] Over the desert section there are landing-grounds every 25 miles, and on other parts of the route the greatest distance between any two landing-grounds does not exceed 140 miles."[2] Yet the number of our countrymen wishing and willing to fly to India, even with State assistance towards the fare, in a series of 'hops' over desolate mountains and trackless deserts, rather than by a restful and refreshing sea voyage, must be few indeed; for aerial transport is admittedly comfortless, more

[1] The W.T. (Wireless Telegraphy) Station at Ismailia alone is estimated to cost £20,800.

[2] *Airways*, October, 1926.

dangerous, more unreliable, and more expensive even with State assistance than other means of travel.

The subsidy agreement provides that for each completed flight from Cairo to Basra the sum of £1,200 will be paid, or over £1 per mile: "a completed flight" in this section is defined as a flight entirely by air with a three-engined machine, and completed within five days. For the section Basra to Karachi the subsidy is £900 for each completed flight, or 14s. per mile. The fare from Cairo to Basra is £51; to Karachi, £72. It is to include lodging and meals throughout the journey, and allows 225 lbs. per passenger including luggage. Should the passenger himself be unusually heavy, he will have the novel experience of paying excess fare for his own person. The charge for weight above 225 lbs. is no less than 6d. per lb. per 100 miles, or 5s. 6d. per lb. for the section Cairo to Basra; for the journey Cairo to Karachi, a distance of some 2,500 miles, the charge for excess weight or freight is reduced to 4d. per lb. per 100 miles—making the cost 8s. per lb. for the entire journey.

On the authority of Lieut.-Colonel Moore Brabazon of the Royal Aeronautical Society, and a prominent member of the Royal Aero Club, there is no semblance of comfort in aeroplane travel:

> "He objected to being made seasick when flying. He objected to sitting in a machine for several hours 10 feet away from two engines developing 450 h.p. each, with open exhausts. He objected to the proximity of the passengers to such inflammable material as petrol, and hoped that some other fuel might come into use which would not present such great fire risk."[1]

Major Oliver Stewart, a great air enthusiast, endorses this view. He says:

> "Air travel differs from road and sea travel chiefly in that air passengers get very little air. In

[1] *Flight*, 22. 4. 1926.

an open car or on a promenade deck the traveller is bathed in fresh air; not so the passengers in a big air express. Ranged like apples in their winged packing case, these passengers are whirled over seas, hills, and meadows to their destination, where a lid is opened and they disembark.

"During transit, as the world slowly unrolls beneath them, they hear thunderings and screamings, and they feel a gentle tremor. These things testify that the conglomerations of rubber, mica, and metal on each side of the cabin are pumping out some 900 h.p. But of the free air rushing past the passengers feel almost nothing. Thus they lose much of the exhilaration of high-speed flight, and they miss the vitalising, clarifying air bath which is given to the pilot and passenger in an open machine. If air travel is ever to be as good for the health as sea travel, it will be necessary on air liners of the future to provide a number of open seats in which begoggled, hide-wrapped passengers can have fresh air poured into their lungs."[1]

At a debate at the Royal Aero Club on Civil Aviation,[2] opened by Air Vice-Marshal Sir Sefton Brancker, Director of Civil Aviation, Captain Barnard, a very famous pilot, "deprecated the attitude of talking about air travel as safe, when we knew it to be the most unsafe of all methods."[3] Major C. C. Turner said: "Reference had

[1] The *Morning Post*, 25. 5. 1926.

[2] Reported in *Flight*, 24. 12. 1925.

[3] The singular method of gauging the percentages of fatalities by giving miles flown is ably exposed by the *Morning Post* (6. 10. 1926) in the following terms: "After every serious air accident aviation companies advance an irritating fallacy to show that air travel is safe. 'Since 1919,' they announce, 'the X Company has flown 4,500,000 miles with only four deaths to passengers.' The statement is quoted in eminent newspapers, and the public is reassured. The figures are supposed to prove the safety of air travel; in fact, they only indicate the British public's weakness in mathematics. For the figures mean precisely nothing. Only four passengers may have been carried, when the death rate would be 100 per cent. Fallacious juggling with

been made to the French railways as compared to aviation for safety. He did not think it wise that the comparison be taken further, as some surprises might be unearthed." In the opinion of Mr. Colebrook, "aviation did not pay because it was not safe and not reliable,"[1] while Mr. Holt Thomas asserted that the London-Paris service could pay if "it carried mails instead of passengers.[2] The present passengers he described as 'joy-riders' rather than serious air passengers."

At the American Hearings it was stated that "the majority of the passengers on the Cross-Channel services are American tourists."[3] Of the thirteen passengers in the new Farman Goliath Air Liner, which collided with a haystack 3 miles from Lympne on the 18th August, 1926, eight were American, four British, and one Italian. Indeed, "the statistics at Le Bourget show that only about 28 per cent. of the passengers passing through that port from England are Englishmen."[4]

Referring to the high cost of Civil Aviation in this country Sir Samuel Hoare affirms—

> "that an analysis of the French, German, and American figures showed that the British lines were the most economically operated."[5]

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figures will not inspire the public with confidence in air travel. If I wish to know how safe is air travel I must discover the percentage of passengers killed in a given period and compare the results with rail, road or sea travel."

[1] In this connection it is significant to note that at the Conference of the International Air Traffic Association, August, 1926, the British representative would not admit, as regards the legal liability of air transport lines, that they came under the definition of common carriers. (*The Times*, 2. 9. 1926.)

[2] "Mr. Charles Dickinson, holding the air mail contract between Chicago, St. Paul and Minneapolis, notified the Government, August 16, that he desires to relinquish his contract. He claims all air mail lines lose money." (*U.S. Army and Navy Journal*, 21. 8. 1926.) Canadian air mail routes will be established this year (1927) provided the Post Office Department receives a subsidy of £15,000 from Parliament.

[3] "Hearings," p. 53.

[4] *Morning Post*, 6. 12. 1926.

[5] *The Times*, 21. 10. 1925.

Sir Eric Geddes pointed out (at the Annual Meeting of Imperial Airways, Ltd., September, 1926) that "the German National Company received subsidies for European services alone amounting, he believed, to £750,000 sterling a year. The French Government paid civil aviation subsidies amounting to between £400,000 and £500,000 a year."[1]

The American Select Committee of Inquiry into the Air Services reported, in December last, 1925. They found that "commercial aviation has the *inherent* difficulty of being unable to operate on a profit-making basis,"[2] and Air Vice-Marshal Sir Sefton Brancker, Director of Civil Aviation, has drawn attention to the fact that "in no case within Europe had air transport paid its way, it existed only by the grace of subsidies."[3]

Notwithstanding the fact that aerial transport can never be made to pay, the Air Ministry seem determined to make it popular.[4] The Secretary of State for Air asserts that "the progress of civil aviation depends chiefly on public interest."[5] Speaking at a luncheon at which he was entertained by the Lancashire Light Aeroplane Club, he stated that "as things were, and as they had been, the air had been almost exclusively the province of a limited number of highly trained military pilots, and the problems connected with it had been almost exclusively concentrated in a Government office. That was too narrow a basis for a great development. If we wanted to make full use of this epoch-making discovery,

[1] The *Daily Mail*, 23. 9. 1926.

[2] *Army and Navy Journal* (U.S.A.), December, 1925.

[3] *Flight*, 6. 5. 1925.

[4] At a dinner held after the Lympne Light Aeroplane Races, September, 1926, at which the Secretary of State for Air, the Under-Secretary of State for Air, and the Director of Civil Aviation were present, Lord Thomson said the most hopeful sign he had seen for the future of aviation was the presence at the aerodrome of two bookmakers. He stated his opinion that gambling on air racing would make aviation popular. (*Morning Post*, 20. 9. 1926.)

[5] *Airways*, May, 1926.

we must get into the air men and women of all types and classes, we must get men and women in all walks of life thinking about air problems. It was there that the light aeroplane club, if it proved successful, could be so useful . . . for by this means will be created a sound and instructed public opinion upon air questions." These sporting clubs, now six in number, have each received equipment worth £2,000 and a grant of £1,000 towards expenses in the first year. The total grant for 1925-1926 was £22,000, and in the Estimates for 1926-1927, £13,000 has been directly voted.[1] Sir Samuel Hoare however is anxious that the clubs should in time be self-supporting: "indeed, a great part of the value of the experiment," in his opinion, "would be lost if it degenerated into nothing more than a spoon-fed section of the Air Ministry."[2]

With all the encouragement given and the money lavished upon Civil Aviation it fails to show any real progress, for apart from all other considerations—discomfort, danger, dependence upon weather[3]—aeroplanes can never seriously be regarded as a means of travel or transport for commercial purposes, and for this very simple reason—*approximately four-fifths of the total power installed is required to maintain the aeroplane and its load in the air against the natural law of gravity*, about one-fifth remains to push or pull the load along, and furthermore, "the tractive effort necessary to pull an aeroplane through the air is more than ten times as great

[1] There appear to be additional payments to these Clubs—£10 for each successful pupil and grants for maintenance of machines.

[2] *Morning Post*, 6. 11. 1925, and *Flight*, 12. 11. 1925.

[3] On the 10th March, 1926, Captain Olley, flying from Cologne to London, was, due to an adverse current, eight hours on the journey which normally takes three and a quarter hours. On the same day Captain Wilcockson on an Airways machine, flying from Croydon to Le Bourget, did the scheduled three-hour journey in one and a half hours. (*Daily Mail*, 11. 3. 1926.) It is clear that the south-easterly current, so favourable to the aeroplane going to Paris on that day, would be unfavourable to the aeroplane going in the opposite direction—*i.e.*, coming to Croydon; the time taken by the incoming aeroplane on that day was not stated.

per pound of gross weight as by a freight train. The train will coast on a 2 per cent. grade, whereas an aeroplane requires about a 20 per cent. grade. The unit fuel cost is about ten times as great for the aeroplane, and this proportion may be even greater because the locomotive burns a very low-grade fuel and the aeroplane a very high-grade gasolene. It appears that it costs about as much to carry *1 lb.* of freight one mile in an aeroplane as to carry *2,240 lbs.* (1 ton) one mile in a train."[1]

The new passenger planes from London to Paris develop 1,155 h.p., and can carry fourteen passengers and 700 lbs. of luggage, which gives for each horse-power *3 lbs. only* as paying load.[2] A railway locomotive can draw a paying load of approximately 3 tons per horse-power with well-nigh perfect safety,[3] and in the case of passengers in complete comfort, at a speed that bears comparison with the speed of commercial aeroplanes in still air. The aeroplane with two Napier Lion engines of 900 h.p., which recently flew from Spain to South America in favourable weather and with 'following wind,' carried four persons the whole distance in ten days. Had a large comfortable passenger liner, with the low speed of 15 knots, sailed from the same port in Spain, she would have arrived at Rio with Major Franco. A tramp steamer—an old collier—of 900 h.p., could have transported 2,300 tons of cargo the same distance in thirteen to fourteen days in perfect security without extraneous help or any strain, and have been able to 'turn about' and carry back an equal load. Though the 'tramp' steams at a speed of 10 to 12 knots only, she ploughs her way on without stopping, by night as well as by day—so with great liners and railway trains. Without night services long-distance railway travel would be more costly, less convenient, and the time taken on

[1] "Hearings," p. 542. [2] *Flight*, 1. 10. 1925.

[3] It is calculated that a passenger's risk of death on the railway is so infinitesimal as to be negligible, a one in 1,700,000,000th chance. (*The Times*, 13. 8. 1926.)

the journey would in general be doubled. Aeroplanes are 'half-timers,' and must remain so even with gigantic outlay in the lighting of the route and of the terminal —that is, the *intended* landing-ground.

In this connection it is interesting to examine the recent flight of four R.A.F. machines from Cairo to the Cape and from the Cape to London. This flight is described as a British triumph. It is true that this exploit reflects great credit on the eight officers and men concerned, but reflection shows again the absurd disproportion between the effort and the useful attainment. At very great cost four machines aggregating 1,800 h.p. conveyed eight persons a distance of 14,000 miles in 114 days, giving an average continuous speed of 5 m.p.h. It is stated that the machines kept to a scheduled timetable. With the same horse-power, but at comparatively trifling cost, two tramp steamers running also to scheduled time could have conveyed 4,600 tons of cargo a similar distance *in half the time.*

The rapidity of aerial transport is in reality illusory, except in short or 'relay' flights. Flying hours—hours actually spent in the air—are always given prominence to the exclusion of the total time between scheduled time of start and actual time of arrival.

It is often said that "aeroplanes are in their infancy," and that their present defects and shortcomings will be rectified or removed when time and money have been spent on 'experiment and research.'[1] But it will be

[1] Much time and money—seven years and £55,000—have been expended by the Air Ministry in a vain effort to produce the airman's dream—the helicopter. Government support has now been withdrawn—the attempt is abandoned. Hope now centres on the Cierva Auto-Giro. The prospect of disappointment in this new "Flapper of the Air" is indicated by the remarks of Mr. Handley Page at the Royal Aero Club House Dinner, at which Sir Samuel Hoare was present; he stated that "where commercial aviation was concerned the fancy of the Director of Civil Aviation seemed to run towards Cierva Autogiros and helicopters. He personally could never see very much use in a type of machine which seemed to

appreciated that the internal combustion engine which made motor-cars possible—and later, aeroplanes—has been improved continuously during the past thirty years, and it may be said that it has in all vital respects reached its limit of perfection. Indeed, the Air Ministry emphasise the fact that "the commercial aeroplane has emerged from its experimental stage." Sir Alan Cobham, admittedly the most experienced and successful airman in the world, referring to his Australian flight, categorically stated that—

> "the whole flight had been carried out without any delay due either to machine or engine, so that from a mechanical point of view the aeroplane was as near perfect as any form of transport could be."[1]

It is significant and striking that war aeroplanes, and more particularly war engines, are still in constant use. Indeed, the Company[2] that acquired the enormous stock

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expend all its energy in keeping itself aloft, without making any visible horizontal progress." (*Flight*. 22. 4. 1926.)

[1] *The Times*, 2. 10. 1926.

[2] This Company, formerly the Aircraft Disposals Company, now known as the A.D.C. Aircraft Limited (a principal shareholder of which is Marconi Limited), was formed to take over from the State the whole of its surplus aircraft, engines, propellers, instruments, and warlike stores, which were acquired, according to Lord Thomson, for "next to nothing" (*Observer*, 10. 10. 1926.) The Aeronautical Correspondent of *The Times* has stated that the first cost to the State *in engines alone* entailed an expenditure between £15,000,000 and £20,000,000. The Company now markets some sixteen different types of war engines which in general have only to be dismantled for inspection and after reassembling given a test run before dispatch. (*Flight*, 4. 11. 1926.) Cirrus, Nimbus, and Airdisco engines are types which have undergone some modification. A Cirrus 27-60 h.p. is sold for £260 and a Nimbus 300-330 h.p. for £750, and it is said that there are 1,200 old Siddeley-Puma engines still available for reconditioning into Nimbus engines (*The Times*, 30. 3. 1926.) This Company also supplies all manner of aircraft instruments and accessories, and armaments including machine-guns, bomb-racks, bomb-sights, and release gears—in fact, every requirement for civil or fighting machines. These war stocks are stored in vast sheds at the old National Munition Factory by Croydon Aerodrome.

of war aeroplanes, engines and accessories, claim to be important contractors to the British Air Ministry and most foreign Governments. The Nimbus Martinsyde, a single-seater fighter, can be placed it is stated amongst the most modern fighting scouts: the Nimbus engine—the old war Siddeley-Puma engine reconditioned for service—is advertised as being the lightest engine per horse-power of its type, of exceptionally low petrol consumption, with advantages of simplicity not possessed by modern types. Cirrus engines (27 to 60 h.p.) from this Company's stock are fitted to Moth aeroplanes.

The Company's claim for the all-round efficiency of their reconditioned or unused war stock seems to be well founded, for in the race for the King's Cup in July, 1926, three Moth aeroplanes flew the course, finishing first, fourth, and sixth; and two 'Moths' have since flown to India. At the Bournemouth Air Race Meeting in August, 1926, Cirrus and Nimbus engines obtained nine wins out of ten events. It may have been on this account that at the subsequent Lympne Meeting the engine specification was such as to rule out the competition of these old machines, yet even so the winning machines in these races were not in fact new machines.

In the German Aviation Competition of 1925 the Scientific Society of Aeronautics entered the old Albatros B.2 (on which a large number of German war pilots had been trained), in order to compare the performance of a 1914 model with that of modern aircraft.[1] A pre-war airman, Captain Krupp, who had not flown for seven years until a few weeks before the beginning of the trials, was the pilot of this machine. It was found that apart from speed the reliable old Albatros machine was able to hold its own in every way with its present-day competitors.[2]

[1] Service fliers in America have declared that "the present pursuit plane, possibly the best in any Navy, is almost an exact duplicate of the plane which was built for the Navy and broke a world's record in the 1922 races."

[2] *The Times*, 15. 6. 1925. In a military machine speed is not necessarily an advantage. The racing plane has no military value

Modifications in size, shape or design of wings, and so forth, may be made but *the aeroplane is her engine*, and there is no real scope for generally effective improvement in performance. Mere increases in size, weight, or power, and constant alteration to and multiplication of types are symptomatic that the efficiency limit has been practically attained. Moving in a circle is not progress. "There is a certain balance between the various desirable characteristics of aircraft, and usually, excessive performance in one essential characteristic is gained at the expense of the others.[1] The longest trips must be made with no load other than fuel, and the heaviest loads can be carried only comparatively short distances."[2] So much so that a seaplane with a necessary supply of fuel for any considerable distance cannot carry an anchor sufficiently heavy to give her security in bad weather. Apart from other reasons a seaplane is thereby precluded from being an independent seaworthy craft.

In a series of recent debates in the French Chamber on the material supplied to the Military Flying Corps, the report of a Commission was brought forward. This

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because it lacks six or seven other characteristics, the absence of which makes it of no value—ceiling, manœuvrability and handiness, angle of vision, landing speed; high landing speed requires a "billiard table to land on"—rough ground will crack it up the first time. (Commander Hunsaker, "Hearings," p. 1649.) For reconnaissance purposes speed is inimical to deliberate and accurate observation.

[1] "If we wish to double the speed of an airplane we shall get four times the lift, but we require eight times the power and eight times the fuel." These figures are not numerically accurate, but they do indicate tendencies and "explain the actual fact that extremely high-speed airplanes are very poor weight carriers and have a comparatively short cruising radius." Again, "2 square feet of wing surface has double the lift of 1 square foot" and double the gross weight can be carried, "but when we double the wing area we also double the air resistance and hence double the power required, double the rate at which the fuel must be consumed, and hence, double the weight of fuel must be carried to fly a given distance." This is a generalisation and shows that "increase in size has in itself very little merit as far as cruising radius is concerned." ("Naval Aviation," p. 22.)

[2] "Hearings," p. 27.

Commission found that "much money had been spent in recent years without producing any appreciable improvement in the service. During the six years from 1920 to 1925, roughly 1,350,000,000 francs had been spent on aviation *matériel*. . . . The verdict on the result had been that there was some improvement in observation machines, none in bombing machines, and an actual falling off in the quality of fighting machines."[1]

Perhaps spectacular trans-oceanic and trans-continental flights have done more than anything else to propagate a world-wide belief in the possibilities of aeroplanes as a future means of transport over great distances. It may be stated generally that in all cases trans-oceanic flights have owed what success they have achieved to favouring air currents, while the terrible risk involved has in all cases been minimised as far as possible by surface vessels, detailed to help and render assistance in cases of necessity.[2]

For the San Diego-Honolulu flight, attempted by American naval airmen in August, 1925, ten surface vessels and two divisions of submarines were despatched to patrol the prearranged route. Three seaplanes were prepared for the flight. One failed to start due to engine trouble, the second was forced down after covering 300 miles, and was towed back to San Francisco by the Destroyer *William James*, which fortunately located her. The third, under the late Commander John Rodgers, proceeded on her way but came down 200 miles from Honolulu due tc lack of fuel, for the winds encountered were less favourable than had been anticipated. She had failed to reach the *Aroostook*, the nearest ship station, due to a rain squall and the *reception of wrong directional wireless bearings*. In the subsequent search for this sea-

[1] *The Times*, 11. 6. 1926.

[2] This very proper, if expensive, precaution was taken with the *Hercules III.* when carrying Sir Samuel and Lady Maud Hoare in December, 1926, from Malta to Khoms and Benghazi, a distance of 580 miles. The 2nd Destroyer Flotilla of the Mediterranean Fleet lined the anticipated route.

plane the large fleet of surface vessels and submarines was reinforced by a Destroyer Flotilla.

A recent and striking example of another spectacular exploit is the flight of Major Franco, the Spanish airman, from Spain to Brazil, a distance of 3,649 miles—22nd to 31st January, 1926. Major Franco was not only brave[1] but wise. The ordinary navigational Sailing Directions show that at this particular time, and at no other throughout the year, the whole course (south-westerly) from Spain to Buenos Aires is subject to a north-east wind, with the exception of the neighbourhood of Fernando Noronha and Pernambuco. His longest flight, from Cape Verde Island to Fernando Noronha, was 1,447 miles, his course approximately south-west, and over the whole of this course he flew in the north-east trade wind,[2] which at a flying height of 2,000 feet provided him with a favouring current which could not have been less than 30 m.p.h.[3] Since he was 13 hours 50 minutes in the air from Praia, Cape Verde, to

[1] A serious engine breakdown far from land, a slight change in direction of air current, or a lack of visibility at any critical moment would in all likelihood have proved disastrous. To quote *Flight* (29. 4. 1926), "the aviators displayed qualities of endurance both of body and mind, of purpose and spirit, of courage and daring, and of technical skill and knowledge."

[2] The N.E. trade blowing direct from Cape Verde Island (to the Equator) in the direction of Fernando Noronha and Pernambuco is strong in January. The Doldrums, a belt of calm between N.E. and S.E. trade winds, are narrowest in that region in February; so that the end of January or beginning of February is the most favourable time of the year for this particular trip. These facts are well known to all seamen.

[3] The trade winds are generally stronger during the day and decrease at night. Signor Franco started from Praia at 6.10 a.m. on 30th January and reached Fernando Noronha at 8 p.m. He had intended to fly 300 miles further on and land at Pernambuco, but weather conditions were unfavourable, and he returned to Fernando after having passed over it. The mean speed of the N.E. trade wind (day and night) is given as 15 m.p.h. At a height of 2,000 feet during the day when the wind is strongest, a rate of 30 m.p.h. is probably much below the actual speed of the south-west air current that obtained on this course.

Fernando Noronha, his average speed over the water was 107 m.p.h. It is calculated that at least 30 m.p.h. was due to the current (the N.E. trade dead astern), leaving 77 as engine speed, or in other words the aeroplane was carried 442 miles of the course by current, and 1,035 was covered by engine power and expenditure of fuel. In short, Major Franco proceeded from Spain to Brazil on what corresponded in effect to a moving platform.[1] It is stated that the hearty co-operation of the Brazilian Government, the Navy, and the Meteorological Office, was an important factor in the success of the flight.

Had Major Franco attempted to fly the course (Praia-Fernando Noronha) in the opposite direction (S.W. to N.E.), the estimated engine speed of 77 m.p.h. would have conveyed him only 47 m.p.h. (77-30) on his course, and he would have taken over thirty-one hours and required thirty-one hours' fuel. To cover the distance he would have had to fly 2,387 air miles. In reality, under such circumstances, his fuel would have given out. But Major Franco and Captain Ruiz de Alva did not attempt to return by air; they accepted passage to Spain on the Destroyer *Alcedo*, and the *Ne Plus Ultra* remained at Buenos Aires, having been presented to the Argentine by the Spanish Government.

Referring to the Round-the-World flight by American Air Service fliers in 1924, it is stated[2] that "the one outstanding lesson of the achievement was that it demonstrated conclusively the dependence of the airplane upon

[1] A traveller on a moving staircase is automatically directed to the staircase moving in the direction in which the traveller intends to go. If the staircase is travelling upwards at the rate of 4½ feet per second (3 m.p.h.) and the traveller walks up at the rate of 3 m.p.h., he gets to the top in half the time—he has walked half the distance and been carried half the distance. If only one staircase is available and that one, unfortunately, moving upwards when the traveller wishes to descend, he could walk downwards continuously for one hour (3 miles), but at the end of the time he would not have progressed three steps towards his destination. The result of endeavour in or on a moving medium does not necessarily bear any relation to the effort made.

[2] "Naval Aviation," pp. 103-104.

surface craft in long-distance work; while the fliers were covering their twenty odd thousand miles of flight, approximately 87,000 miles of steaming was done by U.S. Naval vessels alone in helping to make the flight a success." It took *nearly six months* to accomplish the circumnavigation of the world by air.

Discussing the arrangements for the Fonck aeroplane race across the Atlantic from New York to Paris, it was reported:[1]

> "A study of weather records indicates that the best conditions for the air race may come early in August. Having taken on board the immense loads of fuel necessary for a non-stop flight, the competitors will stand ready for an ascent at a moment's notice, the signal being given when wind and other conditions—as ascertained by wireless from ocean liners—seem most favourable."

As is well known, this much-advertised flight ended in disaster within a few minutes of its start on the 21st September, 1926.

Flying introduces great problems intimately connected with the ordinary professional business of sailors, but owing to the general position of affairs and to the control of all air operations in this country, wholesome criticism of enterprises and undertakings is likely to be lacking.

We may some day discover and be able to employ an entirely new source of motive energy, an energy which implies little or no weight, but gravity will still exercise its unerring and relentless force, and the winds—the currents of the air—will always govern the operation of aircraft. On his return flight from Australia (September, 1926) Sir Alan Cobham was detained in Burma for seven days owing to the weather conditions, and on his arrival at Calcutta he stated that had he left Penang half a day earlier he would have escaped the storms and been in

[1] *Daily Chronicle*, 20. 5. 1926.

London then instead of in Calcutta.[1] On the 11th December, 1926, it was reported that due to fog there had been no arrivals or departures at Le Bourget aerodrome on the previous day. "For three days now flights have been practically impossible." The aeroplane service was in fact entirely upset. Two machines which left Croydon on the 10th December had to alight at Beauvais—one carrying Air Vice-Marshal Sir Sefton Brancker: the passengers were obliged to proceed by train. Meteorologists "explain" that the fog was due to the high barometer, the absence of wind, and the prevailing damp. For another complete cessation of the Cross-Channel air services due to snow and cold the Air Ministry "blame" a cold wave from the Arctic regions.

On the 3rd December, 1926, the first air commercial traveller in this country started on his rounds from Brooklands in a three-seater Avro. He was a pilot of much experience. On the 18th December he had arranged to fly from Leeds to Manchester; "owing to the gusty wind the machine actually drifted at one time until it was almost over Manchester (35 miles S.W.), and was then blown away again as far as Blackburn" (20 miles N.W. of Manchester). Finally the pilot attempted to land. He was then at Ripley, 65 miles S.E. of Blackburn and 45 miles away from his intended destination. On his third attempt to land he crashed. The machine was wrecked.

"There are two great handicaps of aviation which exist to-day and will exist 100 years from now—they are bad weather and the law of gravity."[2] These are two of the unalterable facts of Nature; the first, bad weather, will continue to be unaffected by the activities of meteorologists, and the Law of Gravity defies research.

Notwithstanding these serious handicaps some scope for the employment of aeroplanes may reasonably be claimed. In peace or war their utilisation for emergency transport in special circumstances and under favourable conditions may prove of service and advantage. There

[1] The *Morning Post*, 20. 9. 1926. [2] "Hearings," p. 943.

is no doubt that aeroplanes are of value to banks and business firms trading between important and adjacent cities; in undeveloped countries like Australia, where weather conditions are exceptionally stable, they are an attractive addition to transport and communications. The sport of flying may grow in popularity. But the test of the practicability of these civil uses is purely an economic one. If traders or private individuals consider aeroplanes indispensable or sufficiently desirable, and are willing to pay the full cost of the services, the supply will at once be forthcoming by private enterprise.

For survey, aeroplanes may prove an aid to older methods, but the service rendered by aircraft must still be auxiliary, for the fixing of points by the orthodox system of triangulation will always be essential. The great cost of such aerial assistance, including suitable landing-grounds, transport of fuel, the repairs and spares required, in short the whole organisation at the back of all aeroplane operations, makes aerial survey, which at best requires correction, an expensive adjunct to the exact,[1] the strictly scientific and complete system hitherto adopted. Speaking in the House of Commons, Colonel Crookshank, who has had experience of survey both from the air and from the ground, said "an extraordinary amount of experience was necessary" in air surveys "if one was not to waste a lot of time on the job." With regard to the possibility of air survey, he stated: "You may take it for granted that in the British Isles an aerial survey is no use whatever . . . East Africa and South Africa might appear to be a good field for air survey work, but here you have nothing but open country, and the ground system would defeat your air survey, not only in speed but in cost, which, for a 1-inch scale map, would be £1 per square mile as against £4 a square mile."[2]

[1] Allowing for the inevitable error of the human factor.

[2] *Parl. Debs.*, 8. 3. 1926. It is reported that Air Survey Limited are not in a position to pay a dividend to their shareholders. Sir

An "Air Survey Committee" has been sitting, consisting of representatives of the Air Ministry, the Geographical section of the War Office, the Ordnance Survey, the School of Military Engineering, and the Artillery Survey School, with a view to surmounting certain obvious difficulties—necessity of fixed points, correction of false perspective, contouring—in connection with survey from the air.[1] No committee, however strong and representative, would appear capable of freeing aerial survey from the necessity of securing an initial framework of fixed points from the ground. The inevitable errors of perspective can only be corrected at the cost of laborious effort and much expense, if in reality any accuracy can be obtained approximating to the standard —the high standard of accuracy and perfection—hitherto associated with Survey and Hydrography.

It might appear that aeroplanes would be of use in locating forest fires and for fishery protection duties. The Federal Government of Canada, who have had experience of their value in this direction, have decided however to discontinue aerial patrol of the fishing grounds of the British Columbian coast, and the Provincial Forestry Department, on account of the cost, refuses to make any arrangements with the Royal Canadian Air Force for forest patrol during the fire hazard season,[2] while in the United States of America "Secretary of War Davis has notified the Secretary of Agriculture that the Army Air Service will withdraw aid from the Airplane Forest Fire Patrol Service because of scarcity of planes."[3]

Alan Cobham considered "it was up to the Governments of the countries concerned to see that this Company was adequately supported." (*Flight*, 11. 11. 1926.)

[1] Major-General Sir F. Sykes, "Aviation in Peace and War," p. 59.

[2] *The Times*, 22. 5. 1926. The cost of flying in this service is officially given as 54.12 dollars per hour.

[3] *Army and Navy Journal* (U.S.A.), 29. 5. 1926.

The Air Ministry claim other special uses for aeroplanes, such as the protection of crops, the destruction of mosquitoes, and the investigation of wheat and timber diseases. The value of such activities can quite safely be left to the judgment of readers, as can also the employment of aeroplanes for the detection of missing persons supposedly concealed in dense undergrowth.

In the opinion of Sir Samuel Hoare the possession and use of aeroplanes alone made possible the rescue of the leader of the Spanish flight to Manilla, who, in passing over Transjordania, was lost in the desert:

> "For six days he and his companion were missing. Hour after hour, twenty-four machines from the neighbouring commands scoured the desert, covering in their search some 16,000 square miles. At length they found Captain Estevez. Nothing but the search of aeroplanes could have saved this man's life. Nothing but aeroplanes could have scoured in so short a time these great expanses of trackless country."[1]

It may be added with equal truth that nothing but an aeroplane would be likely to land itself in a predicament calling for such a great and friendly—if costly—effort on its behalf.

A detailed account of this search is given in the *Journal of the Royal United Services Institution*, August, 1926. It stated:

> "One of the three Breguet aeroplanes flying from Madrid to Manilla made a forced landing five miles north of the desert track between landing-grounds 'K' and 'L' on the Cairo-Baghdad Air Mail Route on 11th April. The machine was found on the 13th April, but the pilot (Captain Estevez) and his mechanic, who had attempted to walk to Amman, were not discovered till the 16th and 17th; after very

[1] *Flight*, 6. 5. 1926.

> extensive search operations by Nos. 14, 47, and 216 Squadrons and Armoured Cars, they were found in an exhausted condition in the vicinity of landing-ground 'H.' The cars travelled 2,383 miles during the search, and the aeroplanes flew 226 hours 40 minutes."

If it is true, as Commander Burney stated in the House of Commons, that the cost of each and every minute of flying in the R.A.F. is £2, the expense of this kindly enterprise, disregarding the activities of the armoured cars, must have approximated £27,000. For five days these two men had wandered in the desert, unseen from the air. At last one was found in the vicinity of landing-ground "H," 40 miles away from his aeroplane, but it is by no means clear from the account that he was in fact actually located from the air.

There is a considerable body of men and women who, while appreciating its present limitations, believe in a great future for aircraft,[1] and that present failure can be converted into triumphant success by the aid of 'scientific research' which at the present time is almost credited with the power of overriding natural law.

There is assuredly no lack of scientific research in the activities of the Air Ministry, and this department is

[1] It is repeatedly stated that the development of aircraft, following the analogy of motor-cars, will eventually lead to complete success—that in time "flying will be nearly as common as motoring is now." Apart from all other considerations, two points seem to have been forgotten. (1) Motoring developed naturally without Government subsidy or State encouragement, and indeed its early development was hindered by the Law in the person of the Man with the Red Flag. Now the tax on motor-cars brings in a handsome revenue to the National Exchequer. (2) In the case of motor-cars, when the engine fails, the car merely ceases to move and unless the circumstances are exceptional, remains in complete safety; if when its engine stopped, the car left the earth and was hurled upwards through space, engine failure would be most serious, motoring would not be popular, and its dangers would be on a par with the dangers of flying.

steadily increasing. Of about eighty members of the Aeronautical Research Staff four-fifths work at the laboratories at Farnborough, the others are engaged at Martlesham and Felixstowe, and in the Air Ministry's laboratories and headquarters at the Imperial College of Science. The Research Branch at Farnborough alone has a personnel of 1,064,[1] yet according to Mr. Wimperis, Director of Scientific Research to the Air Ministry, aero engines owed their improvement more to the efforts of the builders than to the Physical staff (the Physicists), and there is a consensus of opinion that improvements in aircraft have been due to the efforts of engineers in the manufacturing establishments and not to the Government Research Departments at Farnborough and elsewhere. In the Debates on the Air Estimates[2] Rear-Admiral Sueter said: "I do not think we get anything out of Farnborough but a large expenditure." Another member said: "I doubt whether very much advantage to the aircraft industry has come from the Research Department at Farnborough since the War; I believe that most of the advantage has come from the industry itself."[3]

Speaking on the problem of Air Defence at the Imperial Conference in October, 1926, Mr. Baldwin said: "*We have also an expert Committee enquiring into the question of anti-aircraft research.*" It would be thought that the problems of anti-aircraft gunnery were essentially the

[1] Rear-Admiral Sueter, *Parl. Debs.*, 8. 3. 1926.

[2] *Ibid.*

[3] Commenting upon the official memorandum "The Progress of Experimental Programme, 1924-26," and on the construction of the Government airship R. 101 in particular, *Flight* remarks: "What the memorandum does not point out, but which is now a secret known to everyone, is that the constructional work (of R. 101) has been handed over to a private firm which already has established a very high reputation for its work on all-metal (and more particularly all-steel) construction of aeroplanes. It is believed that this firm has been given a fairly free hand, and although one may not go into detail at the moment, we personally regard this fact as a happy augury." (*Flight*. 16th December, 1926.)

business of gunners and ordnance engineers, and could well be left in their able hands, but 'Scientific Research' has gripped the imagination of the Government, and no less than £4,045,000 was provided by Parliament for the prosecution of 'Research'[1] during the past year alone (1925-1926).[2] Half of this vast sum was allotted to the fighting services—the Air Ministry spending more on research than any other department of State. A very substantial amount is absorbed by the Department of Scientific and Industrial Research; and Manufacturers' Associations alone, for the six years 1918 to 1924, have received for 'scientific research' connected with their own manufactures a total of £394,135. These 'Captains of Industry,' by applying for State aid, admit that they are not able to manage their own concerns and develop their own businesses, and while loudly complaining of high taxation continue to enjoy their pickings from the public purse. What the public has gained or is likely to gain in improved products or cheaper goods in return for this extraordinary and anomalous subvention to manufacturers is not apparent. Strangely enough, while Parliament puts its trust in the power of 'scientific research' to rehabilitate British Trade and revive British Agriculture, and has voted so large a sum for its advancement, the Inland Revenue Department on the grounds of economy is withdrawing the trifling help given in the past in the form of remission of taxation to those great scientific societies that have for many years published and given freely to the country the knowledge that has been discovered within their particular sphere.[3]

The application of a newly discovered truth—the development of a new thing—is, or should be, the province

[1] The term "Research" as now used is a misnomer: the activity which the word conveys could more correctly be described as 'Projection.' Many of the research workers of to-day bear a striking resemblance to the Projectors immortalised in "Gulliver's Travels."

[2] *The Times*, 23. 5. 1925. [3] *Ibid.*, 8. 6. 1926.

of the regular profession to which the discovery is applicable. Into the engineering profession (as into the professions generally) there has intruded a vast body of 'professional scientists' not possessing, nor indeed professing, engineering attainments; their claim to be 'scientists' is based upon no surer foundation than the possession of a degree, which indeed only indicates that they have some knowledge of a special subject. Strange as it may seem, the artistic and literary worlds are more scientific—that is, *correct*—in the use of their terms and in their ideas than that materialistic world which is the sphere of what is called science.

A 'scientific theory' is a contradiction in terms; for Science, if it means anything, means physical truth—quantitative reality.

No truth is new: through the discovery of a truth a new fact is given to the world, which may be called science, though the word 'science' is now thoroughly and persistently overworked. Discoverers are individuals with inborn powers of concentrated and accurate observation, of brilliant deduction from sound premises, of active but disciplined imagination, and of creative thought. They are born not made. The landmarks of civilisation have been set up by original minds. The processes of thought are secret and individual: inspiration—the sudden vision of truth—is neither created nor stimulated by salaries and positions, nor is it quenched by hardship or obscurity.

Clerk-Maxwell was not set to discover wireless. Watt was no 'scientist,' yet by inspiration and observation of simple truths he revolutionised the world. Browning,[1] the inventor of automatic weapons, was the son of a gunsmith, and as a boy of thirteen made his first gun out of scrap iron in his father's workshop. Neptune was not found by employing a 'Scientific Pool' to find a new

[1] An interesting account of Mr. J. M. Browning's many inventions —notable for their extreme efficiency and simplicity—and of his simple and unassuming character is given in *The Times* of 29th November, 1926.

planet. No panel of doctors discovered the circulation of the blood.

A Government that frankly and avowedly bases great policies upon 'scientific theories,'[1] and employs bodies of 'professional scientists,' setting them to 'evolve' some new thing, to discover an obscure cause, to change or develop an appliance or material which may have reached already its natural limitations,[2] encourages, if it does not invite, the development of unsound ideas and theories, since from the nature of things and the self-interests involved, some thing must be produced or some theory advanced to justify the continuance of their activities, if not of their very existence. Ingenuity can always clothe ignorance or impotence with the impressive cloak of complexity and verbal abstruseness.

Efficiency is the test of Truth—simplicity is its hallmark.

[1] The widely held view that it is to 'science and research' we must look for industrial progress and economical resuscitation is stated in plain terms in the *Observer* (16. 1. 1927): "Science can do far more for the commonwealth at this juncture than any kind of politics. It is in the laboratory and not in the legislature that the economic future is being determined." While the former part of this statement cannot be admitted, the latter portion is undeniably and tragically true.

[2] It is clear that the theory of evolution has become the working hypothesis of modern research in mechanism, materials and living organisms.

11

" *The indiscriminate defence of right and wrong contracts the understanding while it corrupts the heart.*"—
LETTERS OF JUNIUS.

CHAPTER XI

AIR WARFARE AND THE BOMBING OF TOWNS AND VILLAGES

THE late War had barely ended and the ink of the Peace Treaty was scarcely dry when the 'Air Offensive' was launched. Peaceful and peace-loving citizens have been assailed with propaganda affirming that "we are in face of a new force of almost limitless potentialities," that "the next war[1] will be fought in the air,"[2] that "air supremacy is victory." We are told that to escape defeat and ruin we must be "supreme in the air"; therefore the nation sanctions without demur, if, indeed, it does not demand, the pouring out of treasure on air schemes of offence and defence, and has confirmed the establishment of a great Ministry whose preoccupation and concern is the development and operation of this new weapon of war—the aeroplane.[3]

It is true, as General Parker (U.S.A.) points out, that the claims of aviation since the War, as compared with what they really accomplished during the War, are surprising. Before sound conclusions can be reached, the powers and possibilities of aircraft should be considered, and the limitations imposed by natural laws on the

[1] The Royal Air Force Pageant (3rd July, 1926) was described as the great "Next War" spectacle. (*Morning Post*, 17. 6. 1926.)

[2] But the evidence of recent events has been too strong, and the Secretary of State for Air has lately stated "it would depend upon the scene of the warfare as to what extent it would be waged in the air." (Sir Samuel Hoare in *Airways*, May, 1926.)

[3] "Aircraft, which in reality were merely torpedo craft which moved above the surface of the water, would undoubtedly play a part in the future. but those who knew how poor was the material record of the torpedo as a weapon, and who recollected that to every one of these forms of attack an antidote had been invented, would not allow their hearts to run away with their heads in the belief that a new and supposedly inexpensive weapon had rendered the existing ones obsolete." (Vice-Admiral Sir H. W. Richmond, K.C.B., *The Times*, 19. 2 1926.)

operation of aeroplanes should not be ignored, for as Major-General C. P. Summerall[1] says:

> "Any arm that is new is always supposed to have some mysterious power. The machine-gun after 1898 was going to decide all wars, and we had advocates of a separate machine-gun corps. . . . Before the War we heard that the French field-gun was going to wipe away all enemies. I was with French artillery officers on the battlefield where the first Marne took place. They told me that they saw nothing for their guns to shoot at. We shall be disillusioned in the same way if we rely too much on the airplane."

In the late War the new weapon—the aeroplane—was used for reconnaissance, photography and spotting, for air combats and for bombing. Experience shows its manifest limitations: it is an unreliable weapon, ineffective and unprofitable—achieving so little, costing so much. It can be demonstrated:

1. *that aeroplane reconnaissance is unreliable;*
2. *that aerial combats in themselves have no influence upon the advance of the army or the ultimate result of the war;*
3. *that bombing is inaccurate, and therefore can only be indiscriminate;*
4. *that bombing attacks on the non-military population (including women and children) are deliberately intended, thereby, it would be thought, offending civilised opinion and international feeling (if not international law);*
5. *that such bombing is inherently expensive, is utterly ineffectual so far as winning the war is concerned,*

[1] "Hearings," p. 1235. Major-General C. P. Summerall was Commander of the 1st Division (U.S.A.), Commander of the 5th Army Corps, the 9th Army Corps, and the 4th Army Corps, "all under combat conditions except the command involving the occupation of Germany afterwards." ("Hearings," p. 1222.)

and that all air operations absorbing, as they must do, enormous man-power and material and entailing an appalling loss of life and wastage of machines, can only be carried on at enormous cost.

These points will be discussed in turn.

1. *Aerial reconnaissance is unreliable; but accurate observation and regular reconnaissance are most desirable in war, and warfare is not confined to fine days.*

Without regular and accurate reports a Commander is at a great disadvantage. Aeroplanes cannot go out in bad weather, observation may be difficult even in fair flying weather, and on foggy or misty days and at night aircraft can see nothing.

On 21st May, 1918, along the line where the German Army broke through, it was reported that the prevailing weather was " very hazy and aerial observation almost impossible."[1]

> " On the 22nd inst. thick morning mist prevented our aeroplanes from leaving the ground during the early part of the day."[2]
>
> " Over half a million of the enemy are trying to burst through the British lines on a front of nearly 60 miles."[3]

The War Correspondent wrote:

> " The Great Battle has begun . . . yesterday, as I told you in my short dispatch, was a day of thick white mist which made it impossible to see more than 400 yards. Later the mist partially lifted, but always it remained fairly dense. It makes work from aeroplanes very difficult, and this was so much to

[1] *The Times*, 22. 3. 1918. [2] *Ibid.*, 25. 3. 1918.
[3] *Ibid.*, 23. 3. 1918.

our disadvantage. None the less our airmen worked throughout the day in spite of the mist, and did, considering the circumstances, valuable work."[1]

"Nowhere was there a fiercer struggle from the beginning of the battle, than in the area between Gouzeaucourt and Epéhy. Here, as elsewhere, the Germans attacked in overwhelming strength . . . screened by the mist they got up close to our line before we were aware of it."[2]

For this attack Ludendorff had been planning throughout the winter. "He conceived that it would be possible to deceive us as to the weight of the blow which he meant to deliver, and to achieve some measure of surprise by keeping the great part of his artillery and the bulk of his attacking divisions at a distance from the battlefield until the last possible moment," but as "no camouflage could altogether conceal from our air observers that something was afoot, and some information would certainly have been elicited from the prisoners taken in the daily skirmishes of trench warfare, . . . he decided to bring up his attacking divisions at the last moment by train and by rapid marches under cover of darkness."[3] The attack actually opened shortly before 5 a.m. on the 21st March, 1918. According to Mr. Bonar Law, only on the 18th or 19th had our Headquarters in France come definitely to the conclusion, which proved correct, that an attack was going to be launched immediately, while a different opinion was held by the British military representative to the Supreme War Council, who believed "that the attack would not take place before the summer."[4]

Speaking at the Hearings of the Morrow Commission on the influence of weather on air operations, Captain Rath, U.S.A. Air Service, cited a whole week in June,

[1] *The Times*, 23. 3. 1918.
[2] *Ibid.*, 25. 3. 1918.
[3] "The Last Four Months," p. 32.
[4] *The Times*, 23. 7. 1926.

1918, when "not a propeller was turned," and recounted other similar periods of aerial inactivity in his sector "on account of the bad weather."[1]

But weather is only one of the causes of unreliable reconnaissance. Speed, an inherent necessity for aeroplane flight, is a grave disadvantage in reconnaissance. Fast flying renders deliberate and therefore accurate observations impossible even in fine weather; the ground may afford good cover, as in Morocco, where the French observers seem to have found it difficult to distinguish a man from a rock,[2] and the height at which an aeroplane must fly to avoid anti-aircraft guns adds to the difficulties.

"A British pilot has confessed that he mistook the large red cross laid out in an open space to protect one of our hospitals at Calais for an iron cross signifying that the Germans were in occupation of Ostend—over which he thought he was flying,"[3] and British airmen on the 29th April, 1917, mistook a Dutch town for enemy territory, and in consequence a sum of £10,000 had to be paid as compensation for the damage done by bomb-dropping.[4]

A report written on 11th June, 1918, by an Officer of "Operations," acting as Liaison Officer between the French Army and the First U.S. Division, reads:

> "Everything has been quiet on our front to-day, except an increase in shelling a little above the normal, and a *British* aviator who dropped bombs out of a cloud and shot up the vicinity of (U.S.A.) Division Headquarters. The blamed fool went home

[1] "August 26th to August 29th (4 days); August 5th to August 11th (7 days); October 11th to 17th (7 days); October 29th to November 11th (11 days). He says, 'I have left out instances of one or two days, because that might happen at any time.'" ("Hearings," p. 1105.)

[2] *Vide* p. 210.

[3] "Air Power and War Rights," p. 263. Calais is more than 50 miles from Ostend.

[4] *Ibid.*, p. 224.

and filled up and came back three or four times between nine o'clock in the morning and three o'clock in the afternoon, and he never did stop his foolishness until he was brought down by a *French* plane. He is in hospital with a broken arm now, and we have two badly wounded men[1] in the hospital as a result of his woodenness. We think that he must have mistaken the station at Breteuil embranchment for the depôt at Montdidier. He certainly had us stirred up for a while."

"It has turned out that the *British* aviator who shot up and bombed us the other day is an *American* who was driving a *British* plane. Things are getting more and more complicated."[2]

Speaking of reconnaissance by aircraft, the official opinion[3] in America is stated thus: "Long-distance reconnaissance will usually be entrusted to aviation. . . . After the determination of such information by aviation, or in the absence or failure of aviation, a reconnaissance by Cavalry will be required. Cavalry cannot be replaced by aviation in ordinary open warfare reconnaissance, for the principal reasons that—

"Cavalry can be used successfully for the purpose at night and under all weather conditions and in thickly wooded or badly broken country.

"Cavalry can give constant observation, whereas, even under favourable weather conditions, observation from airplanes is necessarily intermittent.

"Cavalry can better determine the intentions of an enemy force, as combat will usually be required.

"Cavalry can secure details of information in reconnaissance, such as identifications.

[1] The result of four or five separate bombing attacks entirely unopposed.

[2] "Hearings," p. 1533.

[3] Doctrine taught at Chief of Air Service's Tactical School, Langley Field.

"Cavalry, but not the Air Service, can obtain complete negative information."[1]

"Air reconnaissance can give positive information only of movements observed. It is indecisive, in that only by actual ground reconnaissance can a Commander be assured that troops are not in occupation of woods and cities where they cannot be seen by aircraft."[2]

Field-Marshal Sir William Robertson, writing on the Army Manœuvres of September, 1925, says:

"On the first day of the manœuvres there was some unpractical flying at low altitudes . . . on the second day it was rather significant to learn that at one time the two forces had completely lost each other, and were reduced to guessing almost to as great an extent as in the days before aeroplanes were invented.

"The country afforded a good deal of cover against air observation, but there was no lack of movement, visibility was good, close contact had been established on the previous day, and many sources of information were available that would not have been open in war. Cavalry abolitionists might take note of the incident, for it would probably not have occurred had the divisions been possessed of a proper quota of mounted troops.

"The writer was reminded of what happened just before the Battle of Mons, when special air reconnaissances were to the effect that the enemy present in the neighbourhood was not nearly as numerous as indicated by intelligence reports from other quarters. The latter proved to be the more correct before the day was over."[3]

[1] "Hearings," pp. 1242-43. [2] *Ibid.*, p. 1141.
[3] The *Morning Post*, 28. 9. 1925.

The Official Report of the Manœuvres[1] says:

"During the early hours of the 23rd, the 2nd and 4th Divisions were unduly apprehensive of a hostile offensive. The 4th Division might rightly have feared an offensive on the 22nd, but the concentration of these two divisions had made an offensive on the part of the Wessex Commander on the 23rd an improbable eventuality. A contributory cause to this general uneasiness was inaccurate air information. During the day reports regarding the presence of tanks in forward positions on their fronts were being continually received by both divisions. The accuracy of these reports was generally accepted. In few, if any, of the cases which came under review were the tanks in the positions reported. Frequently the dragons of the mechanicalised artillery were reported as tanks."

"The definite lesson that emerged from the operations of this day is, that though air reconnaissance is invaluable it is not infallible, and must never be taken as such. Where possible, air information must be checked by ground reconnaissance. Where this is not possible, the information must be carefully sifted, bearing in mind the possibilities of the employment of the various arms. A little careful thought would have suggested that it was *more than unlikely* that the majority of these reports were accurate."

"Except in the most open country, air reconnaissance cannot take the place of ground reconnaissance as regards the dispositions of advanced troops."

"Commanders must realise that, though aeroplanes will improve, human vision remains constant, and in addition, as ground protection improves, aeroplanes will have to fly higher. Tactical recon-

[1] *Report on Army Manœuvres*, 1925: H.M. Stationery Office.

naissance by aeroplanes will not therefore improve. *All tactical information received must therefore be carefully sifted and checked by ground reconnaissance.*"

"The lack of divisional cavalry was seriously felt by all divisions. The mobility of cavalry in defence is their main asset. Sufficient advantage was not made of this mobility. . . . The lack of cavalry patrols for reconnaissance purposes was very noticeable."

"Simplicity both in conception and execution is one of the main avenues to success. War is a difficult art. Complicated plans and complicated methods of execution add to these difficulties."

The following is from the Report of the Army Manœuvres in the next year, August, 1926:

> "The object of the exercise was to practise reconnaissance of a river, bridging operations, and the formations to be adopted before and after the crossing has been carried out in the face of an enemy. After a preliminary reconnaissance and some skirmishing with Southland patrols just north of and up to the canal line, the Northern Commander issued his orders at 8 p.m. In compliance with these, the Gordon Highlanders ran a double assault bridge across quickly, silently, and efficiently, at about 2.30 a.m., and within three minutes were advancing. . . . It was of vital importance to the Southern Commander to know the exact crossing-place, on which he might have concentrated artillery fire. The co-operating aeroplane had, of course, no chance of observing in the night. Soon after dawn I was standing near the point of interest, watching a Southland plane overhead, and I thought that the bridge would soon be ruled to be impassable owing to such fire, but I gathered afterwards that *no bridge was visible* to the air observer, *who reported to that effect.*"[1]

[1] *The Times*, 25. 8. 1926.

On the 2nd September "the fighting was intended to show how dreadfully effective the dropping of bombs from the air can be on troops marching in column, for the Southern Commander had commandeered all the machines in the neighbourhood to harass the column of the Northland Army. Approximately 100 bombing machines should have been in the air, spreading desolation among the ranks." "The Southland Army were greatly disappointed with the bad weather, the Commander had arranged some aerial warfare on a grand scale. He was to have provided a big surprise for the enemy, but poor visibility made the Air Force *impotent*."

> "A thick mist in the early morning, followed by a drizzling rain, which as the day advanced became a steady downpour, made an effective and protective screen for the Western or invading army. This protective screen supplied by the atmosphere *eliminated the Air Force completely from the Field*."[1]

On the operations of the day the Correspondent of *The Times* remarked:

> "The R.A.F., though flying was impossible, were still helpful. Their W.T. station intercepted an enemy message locating exactly their defending line."[2]

The experiences of this day are significant. The weather had stopped all air work, and the character of both the defensive and offensive schemes had to be completely changed. The *helpfulness* of the R.A.F. wireless shows clearly how messages by W.T. can be readily intercepted by the other side, with the betrayal of vital information in war.

On the next morning the manœuvres terminated abruptly. "Climatic conditions had for three days put

[1] The *Morning Post*, 3. 9. 1926.

[2] *The Times*, 3. 9. 1926. *Vide* p. 103, note 5.

the use of aircraft out of the question, either for reconnaissance (sorely needed on the Northern side), or for the offensive action which had been proposed on the Southern side. Aircraft could not operate, and this brought out one of the most valuable lessons of the exercise."

At the end of the manœuvres Sir Philip Chetwode addressed a representative assembly of officers, and expressed his opinion of the air question in a pregnant phrase:

"This exercise put the troops back to 1912."[1]

Since aeroplanes cannot operate in bad weather and cannot see in heavy rain, low mists or clouds, or at night, and since air reconnaissance must at all times be checked by ground reconnaissance, and further, since cavalry must be retained for reliable reconnaissance, it seems obvious that air reconnaissance is in fact not only redundant, but a possible danger, as an inaccurate report may be worse than no report at all.

In the late War photography of the opposing trenches was largely carried on at great expense and effort. However accurate and intelligible these photographs proved, it is not clear what useful purpose they served, since a bird's-eye view of the trenches on either side did not help to disturb the stalemate of nearly four years.

Reporting on reconnaissance at sea, Captain J. K. Taussig, Head of the Department of Strategy, Naval War College (U.S.A.), states that aerial observations for obtaining information are not reliable; this is due to the following reasons:

"1. Weather conditions interfere with aircraft more adversely than any other type.

[1] *The Times*, 6. 9. 1926.

"2. Under certain atmospheric conditions aircraft cannot see as well as surface craft.

"3. Aircraft cannot navigate as close to a line as surface craft.

"4. Owing to their rapid speed, and owing to the fact that they cannot stand still, airplanes cannot maintain either a stationary patrol or a line in direct scouting; for continual observation of any specified line or area the number of planes required is very great, and even becomes prohibitive in cases where a reasonable number of surface craft or submarines would suffice."[1]

But these observations do not include the mention of the most important limitation and disability of aerial reconnaissance at sea—the fact that an aeroplane does not know and cannot determine her own position, except under favourable circumstances, if out of sight of her shore base or carrier. Near her carrier her reconnaissance is redundant owing to the presence of surface craft constructed and properly stationed for scouting.

Spotting—that is the observation of the result of long-range gun-fire—is considered an important function of aeroplanes; but weather conditions may prevent the aeroplane from leaving the ground or carrier, and clouds and low visibility may render aeroplane observation impossible. An aeroplane flying near the target may be shot down by the enemy; in any case aerial reports must be sent by wireless, and these can readily be interfered with, if not completely 'jammed' by the enemy. Moreover, if many guns are firing rapidly, the observer in the aeroplane cannot say from which guns particular shots were fired.

How far the value of extensive long-range artillery fire on land is proportional to the cost and effort required to maintain it, and how far the embarrassment to the

[1] "Hearings," p. 1674.

enemy of this terrific bombardment outweighs the disadvantages and difficulties of the subsequent advance of our own infantry, are nice matters for debate.[1]

It is clear that in any case aeroplanes, rushing about in the air at 100 m.p.h., dodging anti-aircraft fire and keeping a sharp lookout for enemy planes, cannot provide by calm and deliberate observation the precise information so very necessary for gunnery. Major-General Sir F. Maurice says: "The accuracy of artillery fire depended upon observation. The guns required eyes, particularly the medium and heavy guns, which fire from a long distance behind the front lines. Even the best observation from aeroplanes will not replace in a great artillery attack the eyes of an observer on the ground connected by telephone with the guns." The Germans realised the limitations and the practical uselessness of aircraft spotting in action, and they therefore "designed the Hindenburg lines so that observation of them *from the ground* should be as difficult as possible."[2]

At sea, while similar considerations hold good and the same general disabilities obtain, it would seem that dependence on aeroplanes for spotting is a danger. In the first place reliance would be placed on an unreliable agency to control what at sea is the primary[3]—the most powerful—weapon; in the second place the belief that aeroplanes make hitting at extreme ranges a practical proposition, tends to its acceptance and adoption and consequently to the development of material appropriate to such extreme ranges and at corresponding expense; in action the presence of aircraft cannot be assured,

[1] The cost of gunfire in the late war must have been staggering, and the magnitude and extent of frontal attacks on both sides makes the charge of Balaclava, the epic of courage and folly, pale into insignificance.

[2] "The Last Four Months," pp. 135-36.

[3] Unlike warfare on the sea, the long-range gun is *not* the primary weapon on land. The Infantry, with the weapons attached to it, is the decisive factor.

their reports may not be received, in any case they cannot be trusted.

Any development in battleships that is contingent on aeroplane co-operation is likely to prove a source of weakness rather than of strength.

2. *Air combats in themselves are irrelevant to the issue and have no influence upon the advance of the army. The real battle—the battle which determines the final result—is on the ground or on the sea.*

Fighting planes are provided for the protection of reconnaissance planes (for observation and photography) and of bombing planes; for the pursuit and destruction of enemy reconnaissance and bombing planes; and for engaging with enemy fighting planes. Their value as protective planes can only be apprised by the effectiveness of the services rendered by the reconnaissance planes and bombers themselves; their value as pursuit planes is similarly determined. 'Stunt fliers' and pilots in pursuit planes who fly at great height and at high speeds can do all kinds of somersaults in the air and are comparatively safe from anti-aircraft guns, but while they are thus engaged they are no use for reconnaissance, nor have they any influence upon or control over the Infantry on the ground below.

Air combats between opposing planes or squadrons achieve nothing but the destruction of life and of aeroplanes. The following gives the American experiences:[1]

> "Our losses were very great among the pilots. In the air when we lose a man he is gone for good. Very few of our pilots are wounded, they are killed. On the ground, the percentage of losses is only about 1 killed to 8 or 10 wounded. A large proportion of these recover and can rejoin their units at a later time. Our airmen can never rejoin. During

[1] Colonel Mitchell, "Hearings," p. 526.

the heavy air fighting in the European War we had to figure on completely replacing the personnel of an active squadron about once a month[1]—that is, killed, wounded, and missing sometimes ran as high as 100 per cent."

At home "the quantity of deaths and other accidents all over the country was enormous. There were nearly 300 pilots killed in England and Scotland during the first quarter of 1918."[2]

Lieut.-Colonel Voisin, who took an active part in the Great War as a French Squadron Commander, says:

> "Of what value was it to the armies upon which, after all, the fortune of the battle depended, for our pursuit planes 'to bring down the Boche' at that distance, if such victories failed to have any effect upon the course of the operations themselves? The Infantry advance is, after all, what most matters, and everything must contribute to further it. As for all other things, and especially preparatory battles in the air, *they are merely episodes*. This was soon proved by the sequence of events."[3]

Comparing the significance of a victorious battle on land, on sea, or in the air, Lieutenant J. G. Ulrich Kessler of the German Navy remarks:[4]

> "A lost air battle signifies practically nothing."
>
> "The first great air battle of the World War took place near Le Cateau on 21st February. Sixty to seventy planes were engaged, thirteen of the enemy and one German were destroyed."
>
> "The largest loss in airplanes was experienced by the enemy on 8th August, 1918. With comparatively

[1] During the St. Mihiel attack (September, 1918) the American Air losses were 50 to 60 per cent. in seven days. ("Hearings," p. 1111.)

[2] Admiral Mark Kerr in *The Times*, 17. 12. 1926.

[3] "Hearings," pp. 1260-61.

[4] *Ibid.*, p. 179.

> slight losses, eighty-three enemy airplanes were counted destroyed behind our line. However, in spite of a victorious air battle, 8th August, 1918, was the black day of the German Army in the history of the World War."

Captain Rath, an American Air Officer of great experience, stated:

> "Strange as it may seem, in St. Mihiel when the American forces moved fastest we were at a standstill as far as the Air Service was concerned in the air. In the Argonne, where we had command of the air, or an air service at least, the first part of the Army did not move so fast."[1]

3. *Aerial bombing is from its very nature absurdly inaccurate, therefore indiscriminate. Successful attacks on specific and protected targets are operations beyond the scope of 'air power.'*

There is no doubt whatever that aerial bombardment must inevitably be indiscriminate. This is true of both day and night attacks. The experience of the War showed abundantly that bombing cannot be carried out with any accuracy. "The height at which the raids were for the most part carried out was such as to make any real precision impossible."[2] To avoid anti-aircraft fire the bombers just flew as high as they could—2½ to 3 miles—and at such a height observation was difficult and any semblance of aim impossible.

All the limitations and difficulties of reconnaissance obtain in even greater degree in finding and recognising the target to be bombed. Foggy or misty weather, the speed of the aeroplane, and the height at which bombers are obliged to fly, all render recognition of the target difficult and uncertain, so much so that it is said that

[1] "Hearings," p. 1111.
[2] "Air Power and War Rights," p. 221.

during the last War " they would very often miss a whole city."[1] Most of the bombing done on the Front in the War was from a height of 14,000 to 15,000 feet. The bombers got up as high as they could. " We flew at those altitudes not because we wanted to, but because we were forced to."[2]

Before releasing the bomb, the pilot must get his machine into a particular position in the air if it is to drop the bomb on the mark. The trajectory of the bomb is the result of its gravity and the speed of the aeroplane. " There is only one place up in the air where a plane can be if it is going to hit the mark," and only during the moment of time when the aeroplane is at that particular spot in the heavens can any bomb dropped fall on its objective (if that objective is of small area, a building or such-like). The ' spot ' depends upon the altitude of the aeroplane, its exact speed through space, not its indicated engine speed,[3] and on its actual direction[4] and angle of flight. The aeroplane drops its bomb and flies on. The pilot in the plane cannot wait and observe the result, he cannot correct his sights and fire again;[5] he is gone, and does not attempt to drop a second bomb on the same target. In the War, a squadron of bombers flying along in formation, on a straight line and at a definite altitude, followed the leader who did the sighting and dropped his bomb, all the following bombers dropped bombs on his sighting. Captain Rath (U.S.A.) says: " We always had a secondary objective which was on somewhat of a straight line with our first."[6] In short,

[1] " Hearings," p. 1108.

[2] *Ibid.*, p. 1106.

[3] Only in a dead calm would speed through space be engine speed.

[4] Actual direction of approach introduces again the question of air current—the wind at that particular height and locality—the speed and direction of which can only be guessed.

[5] In ordinary gunnery operations a ' shot over ' or a ' short ' is not a lost shot—it provides information for correction for the next round, and this correction is applied to the sights.

[6] " Hearings," p. 1104.

bombing from an aeroplane is a problem of *navigating* to a three-dimensional spot, and not a question of aiming. *Sighting*, in this operation, is an attempt to *navigate a bomb* to the point in space which the particular conditions, ruling at the moment of dropping, determine as the one and only spot from which a hit can be obtained. The term *bomb-sight* is in fact an absurd misnomer. It has no connection whatever with a *gun-sight*. The latter is wise before the event, the former is not, nor can it profit after the event.

It is not surprising that " during the World War extravagant tales of havoc done to enemy cities and installations were often brought back, in good faith no doubt, by some of our aviators, but investigation after the Armistice failed in the majority of cases to verify the correctness of such reports."[1]

> " Of the bombardments which took place " during the War, " two things can be affirmed with absolute certainty. The first is that each country was convinced that the bombardments carried out by the enemy airmen were indiscriminate. The second that each was equally convinced that its own airmen exercised care and discrimination in its bombardments."[2]

A striking example of the difficulty of accurate bombing is demonstrated by the experience of the Dardanelles:

> " When the *Goeben* was ashore at Nagara Point in January, 1918, she was repeatedly bombed by the R.N.A.S. ' Altogether some 270 flights were made and 15 tons of bombs were dropped. Only one of all these seems to have hit the cruiser.' "[3]

[1] " Hearings," p. 25.

[2] " Air Power and War Rights," p. 217.

[3] H. A. Jones, " Over the Balkans and South Russia," quoted in " Air Power and War Rights."

Since the War, in August, 1923 and again in July, 1924, experimental bombings have been carried out by the R.A.F. on the battleship *Agamemnon*.[1] The bombs were not intended to inflict damage but to test accuracy of aim. The ship was proceeding at a speed of 10 to 12 knots, directed by wireless, and it is said that there was a wind of 35 m.p.h. In the first test two squadrons of the R.A.F. dropped 223 bombs. The records show that ten of them struck the ship. In July, 1924, another test was carried out: the ship was under way, 114 bombs were dropped, not a single hit was recorded. This demonstrates "the difficulty in the way of bombing even though the ship is not resisting the bombing, but only steaming at a reasonable speed."

The difference between the number of hits recorded in these two trials is significant, especially in view of the fact that on the second occasion, when the experience gained on the previous trial was no doubt utilised, no hits were made though 114 bombs were dropped. A careful study of American evidence[2] on the bombing of ships indicates that in all probability the wind in the former case was fore and aft of the ship, and in the latter was a cross wind, introducing the incalculable factor of current on the aeroplane.

If a ship were steaming directly into the wind and an aeroplane were overtaking her from directly astern, (1) the aeroplane would have no lateral drift and could keep line, thereby eliminating the most important sources of error; (2) the opposing wind would be an adverse current to the aeroplane, reducing her speed relative to the target by an amount equal to the speed of the current, thus giving her more time for deliberation; and (3) the greater the speed of the ship on this course the slower the approach of the aeroplane and the longer again the time for consideration.

This is the ideal condition for bombing ships from the

[1] "Hearings," pp. 608, 981, and 1179.

[2] "Hearings of the Morrow Commission."

air, and is in fact the only one where any semblance of judgment is possible, and explains the curious fact that a fast-moving ship under certain conditions is a simpler target for an aeroplane bomb than a stationary target. At the same time it must be said that a battleship has these conditions within her own power of control and can avoid them simply and effectively.

If the ship were steaming as before, head to wind, but the aeroplane were approaching the ship *bows on*, the approach would be very rapid, the time of passage over the target would be short, for to the speed of the aeroplane would be added the speed of the current and the speed of the ship. In this discussion no consideration of anti-aircraft defence is introduced, the chances of a hit from an aeroplane on a moving but utterly defenceless ship alone are considered. It is clear that such a ship would avoid holding a course that might render her vulnerable to aeroplane attack, and in the unlikely event of the ship's normal course being head to wind, a short alteration of a few points would introduce to the aeroplane the full complement of three dimensional disabilities.

It is hardly to be doubted that the difficulty of hitting specific targets accounted for the absence of any serious effort on the part of Germany to interfere from the air with our vital cross-Channel traffic. During the late War no man-of-war, as far as is known, and only one ship of the Mercantile Marine, was hit by a bomb.[1] Ships pouring across the Channel bearing troops, munitions, and coal, provided targets which must have tempted any enemy Air Force in possession of the North of France or Belgium to pit the Power of the Air against Sea Power. No such effort was made, and while the particular pre-

[1] "The Germans dropped bombs on London 120 miles away from their base . . . at 60 miles away from their base English ships were constantly passing across the Channel night and day; and I want to ask, were any of those ships bombed?" The reply was, "Not that I know of." ("Hearings," p. 841.)

cautions employed by the Navy provided almost complete immunity from submarines to this vital Channel traffic, these sea communications enjoyed absolute immunity from the air.

But perhaps the most significant example of the inability of air power to accomplish what would seem to be an operation entirely within its scope is the failure to destroy the locks and canals at Brugge, a mission which, as stated by Sir Frederick Sykes,[1] was one of the duties allotted to the aircraft stationed at Dunkirk from the early days of the War. A distinguished American Air Officer says:

> " I had the privilege during the War of visiting the area around Dunkirk, and one of the most desirable targets, or the most desirable targets, were the locks and canals back of Zeebrugge, which ran from Zeebrugge to Brugge, and from Brugge to Ostend. To realise the importance of it, by maintaining these locks and canals the Germans were enabled to take their submarines to Zeebrugge, where they were operating from there through the British Channel and the North Sea and out into the Atlantic. They sent them into Brugge for repairs. . . . Now those locks, of which there were two sets, were the objects of all sorts of plans on the part of the British, the French, and the Belgians, in an effort to destroy them. . . . Yet those locks were never destroyed during the War. I spent some time up there watching the large air organisations that the British had and the French in that area. They had a large number of bombing planes there. They explained to me how desirable it was to get those locks and put them out of commission. Months went by, with days like to-day, cloudy weather, and again with clear days. But no bombing raids were carried out against the locks, and it was

[1] " Aviation in Peace and War," p. 73.

wondered why." The Germans had established large guns and installed turrets with heavy artillery; "these remained there until the War was over, in spite of all the bombing raids. . . . There were a great many planes flying back and forth, not particularly after those locks, but flying back and forth, and yet those anti-aircraft units stayed there during the entire period of the War. They were exceedingly efficient. You will hear officers say that they flew all over there and were not hit. That is true. But the locks were not hit, either, by any of the bombs during the War."[1]

It remained for the Navy, by her epic exploit on St. George's Day, 1918, to secure the blocking-up of the canal at Zeebrugge, and to put out of commission a base vital for German submarines.

4. *Bombing attacks on the non-military population are deliberately intended.*

The Conference on the Limitation of Armaments at Washington adopted a resolution for the appointment of a Commission to consider and report any change in international law required to cover new methods of attack or defence resulting from the development of new agencies of warfare. Sitting at The Hague (December, 1922, to February, 1923) this Commission, of which the Hon. John Bassett Moore (U.S.A.) was elected President, has made its report. Article 22, Part II., Rules of Warfare, reads:

> "Aerial bombardment for the purpose of terrorising the civilian population, of destroying or damaging private property not of military character, or of injuring non-combatants, is prohibited."

It is stated that "all efforts of the United States, Japan, Italy, and the Netherlands to prohibit the

[1] "Hearings," p. 835.

'bombardment by aircraft of cities, suburbs, villages, homes or buildings outside the battlefield or the battle zone' shatter on the opposition of England and of France."[1] "After protracted fights" Article 23 was at length accepted and presented to the interested Governments for consideration. This Article (1) limits the aerial bombardment to military targets; (2) defines these targets; (3) forbids not only the bombardment of cities, villages, communities or buildings not in the immediate vicinity of the land forces, but also forbids the bombardment of military targets if these targets cannot be bombarded without involving the bombardment of the civil population, but the fourth clause of this Article "permits the bombardment of cities, villages, communities, and buildings if these are in the immediate vicinity of the operation of the land forces, provided that the military force concentrated there is sufficiently important to justify the bombardment."

This famous clause of Article 23 "justifies in the last analysis all acts of violence by aircraft."[2] It covers the bombing of Moroccan and Druse villages by French aircraft; it allows of the intensive air campaign in Waziristan, for it must be presumed that the military force concentrated in the good-sized villages, the cave dwellings, the scattered huts and enclosures of the tribes, was considered sufficiently important to justify bombardment by the British Air Force for fifty-four days.[3]

Vice-Admiral Sir H. W. Richmond says: "Frightfulness expressly repudiated recently in the case of sea warfare appears to be a fundamental principle in the air."[4]

[1] "Hearings," p. 177.

[2] "Hearings," p. 178. In a report on American and Foreign Air Force Equipment it is stated: "The principal interest in bombing may be conducting of punitive expeditions against savage or semi-barbaric tribes, and in that case *almost any airplane able to fly with two or three hundred pounds of bomb load will suffice.*" ("Hearings," p. 1681.)

[3] *Vide* p. 188.

[4] *J. of the R.U.S.I.*, quoted in "Hearings," p. 178.

There are two schools of thought with regard to the prosecution of war: "one school believes in the application of military force in accordance with international law and treaties; the other believes in the application of military force against combatants and non-combatants alike in the most ruthless manner possible," and is aptly expressed in the following symptomatic passage:

> "The only effect an International Bombing Code can have is to cramp the style of the R.A.F. at the beginning of the war. . . . If we go bang into the next war all hair and teeth and blood, *as the saying goes*, free from any fetters of rules and regulations, we may achieve quite useful results at the start."[1]

The following passage is from the evidence of Major-General Patrick at the Hearings of the Morrow Commission:

> "I heard several reasons given for the war-time change in the English organisation;[2] one was given me by the then English Air Minister, Lord Weir, who said that he and others were convinced that it was necessary to bomb German cities—in other words, reprisals for the bombing done by the Germans against London and other centres of population in England; that the high command in the field on the western front would not release any planes for that

[1] Printed in a British Air Paper in 1923, and quoted in a standard work. The author prefers not to give the precise reference.

[2] The great change referred to was the formation of the R.A.F., and the Air Ministry, as an independent Government Department. This took place early in 1918—Lord Rothermere was Secretary of State for Air until April, 1918. Lord Weir was a member of the Air Board 1917-1918 and Secretary of State for Air from April to December, 1918. Major-General Sir F. Sykes (in *Edinburgh Review*, October, 1925) gives another reason; he says: "The formation of the Air Ministry was primarily inspired by the necessity to eliminate competitive demands for machinery." So far as this reason contributed to the far-reaching innovation it would seem like using 'a steam hammer to crack a nut.'

purpose.[1] The Air Minister, who controlled all of the planes, simply took part of them and placed them in the north-eastern part of France, where they actually did bomb a great many of these German cities."

Major-General Sir F. Sykes was Chief of the Air Staff during 1918 when the Independent Air Force was formed for "definite offensive policy." It originally comprised two day-bomber and two night-bomber squadrons. Major-General Sir F. Sykes states:[2]

> "Theoretically, machines of the Independent Air Force should not have been utilised for attacking purely military objectives in the Army zone, such as aerodromes, and their co-operation with the Army for this purpose shows that *their true rôle* was either not appreciated or not favoured by the French and other Commands."

Major-General Sir Hugh Trenchard was entrusted with the organisation of this new form of aerial warfare against civil as opposed to military objectives.

In the opinion of Major-General Sir F. Sykes:

> "The present development of air forces carries with it an assurance of the use of military power in direct attack on the moral stamina of the non-military subjects of a hostile power . . . and so *by the air . . . has arisen the intention* to employ military force against objectives of a directly non-combatant nature, and many of the rules of warfare

[1] Brigadier-General Parker, U.S.A., has stated: "At no time to my personal knowledge—and I had considerable contact with the French Army throughout the war and our own Army throughout the war—it, at no time, to my personal knowledge accomplished anything of serious import when it was not serving in combination with the other combat branches." ("Hearings," p. 1276.)

[2] Major-General Sir F. Sykes, G.B.E., K.C.B., C.M.G., M.P., in "Aviation in Peace and War," p. 89.

which have hitherto obtained are thereby rendered obsolete."[1]

"Nothing short of the abandonment of war will cause the *fullest use*[2] of these weapons to be surrendered."

The intention to employ air power against non-combatants, including of necessity women and little children, has been carried into effect in the Waziristan campaign. The following is from the official account of the intensive air hostilities, 9th March to 1st May, 1925:[3]

> The targets in this campaign varied from "good sized villages . . . to purely cave dwellings" and "the scattered huts and enclosures of the Guri Khel. . . . Machines were sent over the area at irregular intervals during the day to attack certain definite targets, or to bomb any targets that might present themselves. . . . Except in the early morning and evening the air was very bumpy, making accurate bombing difficult. . . . Night bombing was carried out by individual machines by moonlight, either against targets that were seen or on localities where it was desirable. . . . *No great material damage can be expected from this night bombing*, but it prolongs the blockade into the night, and thus further disorganises the normal life of the tribesmen." The report continues: "it is at present too early to judge how lasting will be the effect or how permanent will be the impression of this display of Air Power on the stubborn tribesmen of the North-West Frontier."[4]

[1] "Air Power and Policy," *Edinburgh Review*, October, 1925.

[2] *Vide* pp. 231-232 on the full use of sea power.

[3] *London Gazette*, 20th November, 1925. In May, 1926, the Air Ministry announced that the Indian General Service Medal, 1908, in silver with clasp Waziristan, 1925, shall be granted for the R.A.F. operations carried out in Waziristan, 9th March to 1st May, 1925. A further notice appeared in December, 1926, inviting applications for these medals.

[4] Dispatch from Air Vice-Marshal Sir E. Ellington to Commander-in-Chief for India, published in *London Gazette*, 20. 11. 1925.

The type of warfare implied in the bombing of towns and villages must surely be alien and abhorrent to the instincts of the British nation, as it must be to all civilised and Christian people. Yet three Flying Crosses and five Distinguished Flying Medals were awarded, and fourteen Mentions were made for "gallant and distinguished conduct" during these intensive air operations in Waziristan.

> "If wars be won only by haphazard night bombardment of towns where there are women and children," writes a very gallant American pilot, "then they had better far be lost."[1]

Discussing such methods of warfare during the Debate on the Air Estimates, Major Attlee said:[2]

> "In Iraq and on the North-West Frontier we are using the Air Force as a weapon to be held *in terrorem*. In fact, we are keeping peace in Iraq to-day because we have the threat of being able to bomb armed forces or villages or inhabitants. Is that really the position accepted by the Minister and by our Air Staff, that in the next war we will utilise the Air Force to destroy the *moral* of any particular enemy country, because if it is so, I think we ought to put some corrections in those advertisements in which we advertise for young men to join the Air Force—very attractive advertisements. 'See the world.' 'It is a man's life.' Yes, but if this is going to be the rôle of an Air Force, it is not a man's job."

[1] J. N. Hall, in "High Adventure," quoted in "Air Power and War Rights," p. 22.
[2] *Parl. Debs.*, 8. 3. 1926.

5. *Aerial bombing, while inherently expensive, is utterly ineffectual so far as winning the war is concerned; and all Air Operations can only be carried on at enormous cost.*

In the last War aerial bombs proved very expensive details of the munition supply, and the number requisitioned must have been very great.

The cost of the bombs themselves, combined with the uncertainty—the impossibility—of aim, made destruction by aerial bombing an enormously expensive undertaking. It is affirmed that the sum spent on demolishing the innocuous village of Souchez, in the late War, would have sufficed to have rebuilt it " fifty or a hundred times over"; a viaduct which required only £14,000 to repair, cost the Germans £80,000 to demolish.[1]

The cost of bombing a battleship at sea by aircraft was discussed at the American Hearings,[2] and shown to be " simply enormous." It was estimated that such a ship might be disabled—not sunk—if four heavy bombs were dropped directly on the ship, or very close to her. One modern aircraft carrier—the U.S.S. *Saratoga* or *Lexington* —is estimated to cost £9,000,000, and is constructed to carry seventy-two aeroplanes, costing an additional £300,000; thirty-six bombers, carrying each one bomb, and thirty-six pursuit planes to protect the bombing planes. Under war conditions, in any kind of weather, with anti-aircraft guns on the battleship and freedom of manœuvre, the chance of one hit would be very doubtful—two hits would be remote. Allowing, for the sake of argument, the good fortune of one hit in action, no great harm would be done to the battleship, but the effort would have cost £9,300,000 in capital expenditure on craft alone. " When the planes go out and drop their bombs they are done, they can never go back to the carrier and get more during that action: she will be

[1] " Air Power and War Rights," p. 246.
[2] " Hearings," p. 609.

chased by destroyers and fast cruisers."[1] True as this may be, it might equally well happen that a cruiser or destroyer would account for the carrier before ever an aeroplane left the deck, if in fact the weather permitted of their employment or their discharge from the deck of the carrier without mishap. "So that it looks like being a very expensive arrangement."[2] Moreover, this huge effort is directed against one ship only, and meanwhile the remaining ships of the line are proceeding with the action proper.

With the guns—to mount which battleships exist—round upon round of heavy and deadly projectiles are aimed at the enemy and fired with tremendous muzzle velocity, and action can if necessary be continued for hours. Aerial bombs cannot be aimed.[3] Their striking velocity, upon which penetration depends, is determined not by the will or the skill of the bomber, but by the force of gravity, in its turn dependent upon the height at which circumstances permit or oblige the pilot to fly. Dropping a few bombs from aeroplanes in a naval battle appears an absolutely negligible effort achieved at the cost of millions of pounds.

It is clear that bombing from aircraft had no material influence on the forces in the Field. Major-General Sir F. Maurice states[4] that the district behind the Yser, where the Belgian Army were cooped in for four years, was incessantly attacked by the enemy's bombing aeroplanes, yet the Belgian Army was ready to take its place in the attack on the Germans in September, 1918, and during these four years King Albert and his Queen, living in a little villa in this district under incessant aerial bombardment, remained unharmed and displayed throughout

[1] "Hearings," p. 982.

[2] Admiral Strauss calculates that an effort which "would not seriously endanger a battleship with crew on board would cost $36,000,000 for airplanes alone" (excluding entirely the enormous cost of the carrier). ("Hearings," p. 213.)

[3] *Vide* p. 180, para. 1.

[4] "The Last Four Months," p. 158.

a bravery, a calmness, a resolution worthy of the highest traditions of Monarchy.

Major-General Summerall, in his evidence at the Hearings (U.S.A.), says:[1]

> "It was my experience to see quite a good deal of enemy bombing. They bombed all our headquarters and some of our troops. Our headquarters in Picardy, Lorraine, Soissons and the Meuse Argonne were all bombed and at different times, *always at night*, by enemy aviators. The casualties inflicted by them . . . were not great. . . . When the Fifteenth Scottish Division relieved the First Division at Soissons the enemy knew they were marching in, although they moved at night. They inflicted a number of casualties, but not a great many. They did not demoralise the division, which was composed of veteran troops, who went about their affairs quite in a normal way. . . . Troops were bivouacked in sparse woods where there was no cover; the enemy bombed that area from time to time, but no casualties were inflicted."

Maj.-Gen. Summerall adds: "In spite of a great deal of bombing taking place there were no material results through enemy bombing among the troops I commanded." General Ely and General Parker also testified as to "the almost negligible effect of bombing on troops in the field," in spite of the sacrifice of men engaged in the enterprise and of the vast expenditure of money involved. General Parker said: "I saw the first German airplane fly over Paris in August, 1914, and I saw the first French airplane fly in the World War. I served throughout the War, and succeeded General Summerall in command of the First (U.S.A.) Division. I think I should like to preface my remarks by expressing a certain surprise which I felt at the claims of aviation since the

[1] "Hearings," p. 1230.

War as compared with what they really accomplished at the end of the War."[1]

Very remarkable corroboration of the truth of General Parker's assertion is to be found in "The Last Four Months," by Major-General Sir F. Maurice,[2] which was published in 1919. In this authoritative work, written shortly after the fateful events which it graphically describes, reference to aircraft is singularly infrequent, and no mention is made of any achievement which contributed even remotely to the final victory. Perhaps the most remarkable and significant allusion to aircraft refers to the time of the great German advance in March, 1918, when the result of the War and the fate of Europe hung in the balance—when the British alone lost 70,000 prisoners and 1,000 guns, and suffered 300,000 casualties. Major-General Sir F. Maurice states:

> "Our airmen who *watched* the long-drawn-out struggle from above have described how, in its last stages, the infantry upon both sides were too exhausted to move, save at a slow walk, and would lie for hours opposite to each other without firing, having lost the energy to load and fire, save in a real emergency."[3]

Throughout the whole narrative the vital and supreme importance of infantry is emphasised, and again and again it is shown that the strength of Sir Douglas Haig's Army depended upon the number of men available for duty in the trenches and in the field.

[1] "Hearings," p. 1276. Brigadier-General Drum says: "In the World War and since, extreme enthusiasts, as well as *publicity artists*, have preached an air doctrine far beyond the possibilities of present or future aviation." ("Hearings," p. 1268.)

[2] Major-General Sir F. Maurice, K.C.M.G., C.B., was Brigadier-General in charge of the Operations Section at General Headquarters in France, and subsequently Director of Military Operations at the War Office. He has been appointed to the London University Chair of Military Studies.

[3] "The Last Four Months," p. 43.

Before the German onslaught, "during the early months of 1918 the drafts sent out from home fell so far short of Sir Douglas Haig's requirements that it was impossible for him to maintain his army any longer at the strength at which it had been during the previous autumn. Accordingly, between the middle of January and the middle of February, three battalions out of the thirteen in each of the British divisions were broken up, and the men in them were used to take the place of drafts from home to fill up the ranks of the remaining battalions. This measure, which was the consequence of the failure of the Government to provide the drafts, caused a drastic change in the organisation and tactics of our infantry at a critical period,"[1] and two of the Cavalry Divisions, owing to the shortage of men, had also to be abolished.[2] It was at such a time and under such circumstances that this country devoted feverish energy to the manufacture of aeroplanes, producing no less than 26,685 aeroplanes[3] from January to October, 1918—ninety per day—and rather more aero engines, involving a retention of enormous man-power in the aircraft factories at home, which (including it is true many women) was approximately 405,000.[4] Moreover, for every aeroplane "in service"—and according to Sir Frederick Sykes,[3]

[1] "The Last Four Months," p. 22.

[2] As events proved, it was Cavalry that stopped the gap in our lines in March 1918: Ludendorff in his book deplores his lack of mounted troops at this critical time.

[3] "Aviation in Peace and War," p. 83.

[4] For an output of ninety aeroplanes per day, 405,000 men would be required. It was reported at the American Hearings (p. 620) that Vickers, Limited, employed 1,100 workers to turn out one aeroplane per day, and the Napier Company with 1,700 men produced fifteen engines per month: thus 3,400 men were required to produce one Napier Lion engine per day and 4,500 to produce one aeroplane with one engine per day. This estimate does not make any allowance for the enormous number of men in the works and factories producing machinery and materials for the aircraft factories. Wood was required in enormous quantity and the world was ransacked for spruce. According to Sir Samuel Hoare, there is not enough suitable wood in the world to-day to allow for another Air War with wooden machines.

22,171 were "on charge" in October, 1918—eighty-four men were retained on the ground.[1] If a great proportion of the aeroplanes "on charge" were "in service," the personnel required for ground service alone would exceed 1½ millions.[2] Flying personnel (pilots, observers, and gunners) would increase these numbers to a total little short of 2 million men directly engaged in the manufacture and operation of aeroplanes. Such a vast reinforcement to our infantry as this body of men in France and at home could have supplied, would, it is only reasonable to suppose, not only have avoided the terrible disaster of March, 1918, but would have brought victory at an earlier date and at a less terrible cost. The vast air effort of this country was tested at that time and failed. Air reconnaissance did not give timely warning of the selected area of the German 'break through,' and while the battle was raging along the front and the men on the field were fighting 'with their backs to the wall,' the men in the air could but *watch*.

The loss of life in the flying personnel must have been terrible. The American statement as regards their flying casualties has already been quoted, and it emphasises the fact that in the air, death is the rule, injury the

[1] Lord Thomson (*The Times*, 11. 3. 1926) and Sir Philip Sassoon (*Parl. Debs.*, 25. 2. 1926). It is not clear that this number of eighty-four included mechanics engaged on repair work. At one station alone established at Courban for the repair of the bombing planes of the Independent Air Force, 10,000 men were employed. (*Aeroplane*, 1. 12. 26.)

[2] This figure is staggering, yet it does not allow for any ground force for one aeroplane out of every five on charge. Any over-estimate in this total for ground personnel implies a proportionate increase in the number of aeroplanes "on charge" but not "employed." For every machine "employed in Air Units" at the present time the Air Ministry employs fifty men on ground service. The present figures of R.A.F. personnel and aeroplanes in Air Units, when allowance has been made for reduction from eighty-four to fifty groundsmen per aeroplane, indicates that the figure of one and a half millions is reasonably near the mark.

In the U.S.A., 80 per cent. of all Air Forces are ground men and establishments. ("Hearings," p. 1266.)

exception.[1] From the wastage of aeroplanes the loss in flying men in the late War may be gauged.

The dangers of flying however are not confined to war-time and the vicissitudes of active service, and the number and the nature of the fatal accidents to airmen every month is harrowing. From 30th June, 1925, to 30th June, 1926, sixty-nine of our airmen were killed and eighty-nine injured, yet the Secretary of State for Air affirms that these casualties compare favourably with those of other Air Forces.[2] In the following month (July, 1926) ten R.A.F. aeroplanes crashed, including the Vickers-Vernon Bomber in Iraq, which alone resulted in seven fatalities. During August, as a result of accidents, thirteen airmen met death.[3]

Apart from accident the flying life of a pilot is notably short. The cost of training a Service Pilot in the R.A.F. is given as in the neighbourhood of £2,000.[4] Even at this conservative estimate the 2,163 pilots ready for war service in December, 1925,[5] have cost the country no less than £4,326,000 for training alone.

Air Chief Marshal Sir Hugh Trenchard,[6] speaking at Cambridge University, said that he anticipated a wastage of aeroplanes in war as high as 80 or 90 per cent. per month. "Pilots were not so difficult to supply, though there was difficulty in that direction, and he hoped that an Air Force Squadron would be formed in the University." The sum total of the losses in machines during the late War must have been very great. It was stated in evidence that the U.S. Air Service in Europe received from all sources 6,010 planes, and the number available at the Armistice was only 547,[7] implying a loss of 5,463 planes

[1] *Vide* pp. 176, 177.

[2] *Parl. Debs.*, 28. 7. 1926.

[3] From 1st January to 18th November, 1926, seventy-eight deaths occurred in the R.A.F. personnel alone. (*Parl. Debs.*, 22. 11. 1926.)

[4] *Parl. Debs.*, 1. 6. 1926.

[5] *Ibid.*, 2. 12. 1925.

[6] *The Times*, 30. 4. 1925.

[7] "Hearings," p. 1533.

during the period of their comparatively short campaign. Brigadier-General Warner has pointed out that:

> "During the War the life of an aeroplane, which was not crashed or anything of that sort, but had to live out in the open and not in a proper covered house, was only about a month."[1]

During 1923-1924 the number of machines employed in units was 750, the number *written off charge* was no less than 710. During 1924-1925 the average number of machines employed was 900, and the number *written off* amounted to 527.[2] In December, 1925, Sir Samuel Hoare stated[3] that 600 machines were "ready for war service in emergency." The disparity between the 600 machines "ready for war" and the 900 machines "employed" is sufficiently noteworthy to account for the constant discussion and enquiry as to the relation between the number of personnel in the Air Force and the number of aeroplanes. Since fifty groundsmen are required for each aeroplane and the R.A.F. numbers 45,000, it is obvious that the average number of machines *employed* is 900—only two out of three of which are ready for war service.

The peace-time wastage of aeroplanes is disquieting. During the period 30th June, 1925, to 30th June, 1926, 262 aeroplanes were written off the Air Force charge as a result of crashing alone,[4] and the Secretary of State for Air estimates the monetary loss at £500,000.[5] The loss of 262 represents nearly half the number of aeroplanes that were stated to be ready for war service in emergency in December, 1925, and the crashing of so many service-

[1] *Parl. Debs.*, 25. 2. 1926. [2] *Ibid.*, 6. 7. 1925.

[3] *Ibid.*, 2. 12. 1925. The distribution is approximately: 100 in the Fleet Air Arm, 200 distributed between Iraq, Egypt, Palestine, Aden and Malta, and 300 at home (calculated from data given).

[4] From 1st January to 18th November, 1926, 230 aircraft were written off charge as a result of crashing alone, and "do not include aircraft written off charge as a result of enemy action." (*Parl. Debs.*, 22. 11. 1926.)

[5] *Parl. Debs.*, 28. 7. 1926.

able machines, in perfect order, reveals the ever-present and inherent danger of mechanical flight.

Turning to the cost of aeroplanes and their equipment, Sir Philip Sassoon, during the debate on the Air Estimates, stated that "an aeroplane costs between £3,000 and £15,000," and that "some of the single-engine squadrons carry as much as £250,000 worth of technical equipment."[1] The sum of £109,800 (over £4,500 each) was set aside to meet the cost of twenty-four planes for the two aircraft carriers *Glorious* and *Courageous*,[2] and the new triple-engined seaplane of 2,000 h.p. is reported to have cost no less than £60,000.[3] The present cost of aircraft is undoubtedly less than it was during the last year of the late War. Assuming an average price of £4,000 each for the 26,685 aeroplanes made in the first ten months of 1918 only, the sum of £106,740,000 is arrived at. It may well have been very much more, for bombers, of which there were many, far exceed fighting planes in cost. This takes no note of the aeroplanes supplied before January, 1918. At the end of 1914 we were producing 200 machines a month,[4] and during the years 1915, 1916, and 1917 the output of these expensive and short-lived weapons of war steadily increased to nearly 2,670 per month. Appalling as these figures are, air enthusiasts aver that the operations of aircraft in the late War were in the nature of "side-shows" only, and that flying will be "developed to such an extent that flying combatants can be counted in tens of thousands instead of hundreds."[5]

The extensive and numerous aerodromes and air stations, some forty in number in this country, with technical and administrative staffs, are all considerable items in air expenditure, and seem disproportionate to

[1] Debate on the Air Estimates, 1926. "From ten to twelve machines are available in each Squadron." (Sir Samuel Hoare, *Parl. Debs.*, 2. 12. 1925.)

[2] *Parl. Debs.*, 19. 3. 1925.

[3] The *Morning Post*, 21. 6. 1926.

[4] *Parl. Debs.*, 25. 2. 1926.

[5] "Air Power and War Rights," p. 13.

the present numbers of machines and pilots. The Air Force, including civilians, numbers 45,000 men, and for every aeroplane in the Service Squadrons there are three officials at the Air Ministry.[1]

At sea, as part of our Fleet Air Arm, seven vessels have been reconditioned or constructed as floating and mobile aerodromes at great cost, a cost which must have proved a heavy burden on the Naval Estimates. H.M.S. *Argus* was built as early as 1918. Her first cost was £1,307,615, and £275,000 has been expended by the Admiralty on her latest alteration and refit.[2] H.M.S. *Furious*, "probably the ugliest ship in the British Navy," is stated to have cost over £6,000,000 from first to last.[3] The disproportion between the cost of air stations and aerodromes. and the number of aeroplanes housed is even more accentuated in aircraft carriers. The First Lord of the Admiralty, the Rt. Hon. W. C. Bridgeman, gives the Fleet Air Arm as 105 planes and adds that "the number is sufficient to equip *Argus*, *Hermes*, *Eagle*, and *Furious*."[4] The total cost of these four vessels—floating hangars, not fighting ships—must have been many millions.

The Americans are converting two battle cruisers, *Lexington* and *Saratoga*[5] (33,000 tons and 180,000 h.p.), into aircraft carriers which will be able to launch about seventy to seventy-five aeroplanes each. The total cost of these two vessels is approximately £18,000,000. "When these aircraft carriers put out to sea they will have cost the Government 44 million dollars apiece; either of them will cost more than any battleship that has ever been built."[6]

The Americans fully realise the fabulous cost of aircraft operations, and have no delusions about the economy of air power, though they have no separate air arm and consequently no overlapping of personnel and organisation. At the Hearings of the Morrow Commission the

[1] *Parl. Debs.*, 25. 2. 1926.
[2] The *Evening Standard*, 19.1.1927.
[3] *Ibid.*, 8.9.1925.
[4] *Parl. Debs.*, 19. 3. 1925.
[5] *Cf.* p. 190.
[6] "Hearings," p. 213.

Hon. Curtis D. Wilbur, Secretary of the United States Navy, said:

> "I think the uniform testimony of all the officers, including Admiral Strauss, would be that in their judgment the method of aircraft defence is one of the most expensive yet devised."[1]

Captain Yarnell, U.S. Navy, declared:

> "Aviation is a terribly expensive arm of the national defence, and that expense is inherent and not due to any system of organisation."[2]

Rear-Admiral Strauss stated:

> "Treating this question purely as one of expenditure for the defence of the country, we have been assailed . . . with the cheapness of defending our country by aircraft. It is a most expensive means of defending your country, even admitting it is as good defence as can be devised. . . . The cost of aircraft defence on land and sea is simply enormous."[3]

It is evident after the experiences of the War that the activities of aircraft are as prodigal in men and money as they are irrelevant to the issue. An Air Force cannot take a position nor hold a position. There can be no domination of an opposing army nor control of a *hostile* people without occupation.

The throwing of bombs from aircraft may terrorise: "it is unable to further the war aim";[4] in truth, such bombing may be considered as the hooliganism of war[5]—causing

[1] "Hearings," p. 156.

[2] *Ibid.*, p. 941. Captain Yarnell, U.S. Navy, in Command of the Aircraft Squadrons of the Scouting Fleet.

[3] "Hearings," p. 213.

[4] "Development of International Law after the World War," by Otfried Nippold, translated by Professor Hershey, p. 197.

[5] A hooligan throws a stone, strikes or tries to strike, and then runs away—an aeroplane drops a bomb, and it must be off. It cannot take anything or hold anything.

suffering to non-combatants in the struggle without any furtherance towards the attainment of the object. It may even be said that if such methods are approved and employed, the aim of the war stands condemned.

Only a section of a determined people can as a matter of fact be terrorised; the great majority are enraged and stimulated to increased effort and resistance. Field-Marshal Sir W. Robertson says:

> "Raids on non-military places and people may be regarded as barbaric, and they may, by exasperating the inhabitants, have the opposite effect to that intended—breaking down of the country's moral."[1]

This is precisely what happened among the Druses, necessitating the dispatch of a large military force. Air force did not create "the complex of defeatism"[2] in the minds of these high-spirited and warlike tribes.

In Zoller's opinion, the airmen's achievements during the late War, "in so far as they attempted to carry destruction into the hostile ranks," were slight, indeed, "directly insignificant,"[3] and events "have shown plainly enough the uselessness of this procedure [the dropping of bombs] and have proved to the whole world that the warfare in the air is really nothing but a war of reprisals."[4]

Brigadier-General Hugh A. Drum, discussing the fundamental principles of warfare, states:

> "With the development of any new instrument of war, extreme views on the theory of war are advanced, especially in peace. Based on such theories, imagination coupled with self-interest dictates extraordinary views and conclusions. In many instances during the World War and since, we find the enthusiasts of special weapons, such as machine-guns, gas, tanks, airplanes, long-range

[1] Quoted in "Air Power and War Rights," pp. 15-16.
[2] *Vide* p. 111.
[3] Quoted in "Development of International Law after the World War," p. 144.
[4] *Ibid.*, pp. 144-45.

cannon (Paris gun), grenades, liquid fire, etc., claiming a revolution in the theory of war. These enthusiasts fail to distinguish between the theory or conduct of war and the application of new weapons to warfare. In peace we are all prone to forget the lessons of war, and to give the greatest attention to the mechanical side of war. There are two schools or theories of conduct of war: one gives greatest weight to mechanical devices, the other realises by dire experience that the decisive factor is man, the human element. Such was our experience in the Meuse-Argonne battle. The dough-boy was decisive, not the airplane, the artillery, gas, etc. The development of aviation is the latest mechanical basis for a new gospel of the conduct of war. Coining the new and catchy term 'air power,' the proponents go so far as to claim that an enemy may be defeated by missiles dropped from the air."[1]

It has recently been justly said that judging by experience, "aerial warfare may be forbidden without disadvantage to the belligerents, but with great profit to the civil population."[2] Profitable in all ways would it be to the civil population of this country had it the self-reliance and the will to abandon all idea of air supremacy, stop following this will-o'-the-wisp, and while developing *natural counters*, cease to throw its millions to the winds.

This does not necessarily imply that aircraft have no value for military purposes. For the Navy a limited number of seaplanes may, under special circumstances and weather conditions, prove of value for long-distance off-shore scouting from important strategical points at home and throughout the Empire. A few seaplanes capable of easy stowage on board or of being hoisted at davits like sea boats, may well prove useful and handy

[1] "Hearings," p. 1247.
[2] "International Law after the World War," pp. 144-45.

for many and varied purposes. All naval craft should naturally be seaplanes, manned and maintained by ordinary naval ratings, to whom such work would be child's play. *Flying in itself is not a profession.* The value of the extensive use of aircraft at sea seems incommensurate with the great cost of aircraft carriers, apart from the grave tactical disadvantages which their presence in battle entails, their extreme vulnerability, and the necessity of detaching ships for their defence.

For use in the Army, aeroplanes may be of value for provisioning and for maintaining communication with a beleaguered garrison, as at Kut in the late War. Aeroplanes can afford emergency transport and communication where alternative facilities do not exist or have been interrupted. Their true place in general reconnaissance has yet to be ascertained—their weakness in many respects for this purpose has already become evident.[1] When the Army and Navy control their own aeroplanes, their part in the general scheme will no doubt in due course be determined. It may be said that an adequate supply[2] of aeroplanes for all legitimate and effective service purposes will amount to a small fraction of our present commitments, and great economy with increased efficiency in defence may be achieved.

Before the Great War Britain was a rich nation with credits all over the world, yet the burden of armaments was felt, and the Army and Navy Estimates were critically examined and reduced. Britain now has not only lost men, treasure, and markets, but she is in debt to one nation, and has acceded to the compounding of her war credits. At the same time, impoverished as she is, she is shouldering increased burdens and has paid on a new Service, between April, 1919, and April, 1926,

[1] *Vide* pp. 165-176.

[2] The provision of aircraft would naturally become the province of a Joint Board, somewhat similar to the old-established Ordnance Board.

no less a sum than £158,897,930 in these seven years. Other countries have expended correspondingly large amounts. France has spent during the six years from 1920 to 1925 roughly 1,350,000,000 francs on aviation *matériel* alone with little result,[1] and the Chamber has decided to appoint another Commission to report on the whole matter. America has used over 1,800,000,000 dollars for aircraft since 1917, and yet it is stated that they have not got a tenth of the aircraft that would be necessary if they went to war to-morrow.

Looking back on the years since the War, and computing the world's expenditure on aircraft, air schemes, and air activities, nothing is more remarkable than that this staggering expenditure—an expenditure totally unproductive, which must have materially contributed to the economic breakdown of Europe—has resulted in a shrinkage of aircraft from vast air fleets to a limited number of squadrons. Since April, 1919, *while still drawing on war stocks*, this country has expended nearly 159 million pounds through its Air Ministry alone; yet for every thirty-six aeroplanes we then possessed we now have one.

[1] *Vide* p. 148, para 1.

"*How oft the sight of means to do ill deeds,*
Makes deeds ill done!"

SHAKESPEARE.

CHAPTER XII

FRENCH EXPERIENCES IN MOROCCO AND SYRIA

A FURTHER COMMENTARY ON 'AIR POWER'

AT the end of April, 1925, Abd el Krim launched an offensive in Morocco with his native tribes—"vigorous mountaineers, fleet of foot and sure of eye, excellent marksmen." His armament consisted of rifles and machine-guns of different European patterns, of hand-grenades, the latter being thrown with great precision at an astonishing distance with slings, and of a few guns used with great accuracy in the attack on several French posts, and of a few aeroplanes.[1] He was opposed by the greatest military Power possessing the largest and most up-to-date air arm in the world, an abundant supply of the most modern armament, and aided by all the resources of Spain.

Notwithstanding the remarkable disparity in *matériel* and general war paraphernalia, it was reported in the *Temps* on the 7th August:

> "Since the end of April each day has been marked by the fall of a post, the defection of a tribe, a gain of ground by the enemy or a withdrawal of our line . . . in the posts that he has taken, Abd el Krim has found guns, trench mortars, machine-guns, rifles, grenades, and hundreds of thousands of rounds of ammunition."

This had not resulted from any slackness of the units of the French Air Arm, for they had been incessantly active, having brought against the Riffs their great *Goliath* bomber and other fighting and bombing planes.[2]

[1] *English Review*, September, 1925. Major Milling (U.S.A.) at the Hearings of the Morrow Commission stated: "the Riffs had no aviation at all" (p. 1067.)

[2] Along with other types the Goliath long-distance bomber was later converted into an air ambulance, but this big bomber "has

In the fighting on 22nd May alone, "one squadron made thirty flights and dropped nearly 500 bombs on hostile parties and on villages of revolted tribes."[1] French Army Orders record that the 37th Regiment in three months accomplished "more than 6,000 hours of flight and carried out more than 3,000 missions, of which 2,000 were for the purpose of bombing the enemy, more than 200 tons of bombs being dropped. The number of wounded transported by aeroplane exceeded 500; this admirable task has only been accomplished at the price of heavy losses."

> "The part being played by aeroplanes in the campaign becomes larger and larger. The French squadrons are now carrying out about forty bombing flights a day besides keeping up communication with outlying posts."[2]

But though air power was used extensively, the Riffs were not quelled; the *moral* and fortitude of the tribes were not materially disturbed; their leaders continued to display calm and confidence. The French War Ministry stated that the Riffs managed "cleverly to take advantage of the terrain and protective methods"; their mobility was amazing, and they demonstrated the effectiveness in warfare of sharp-shooting and accurate rifle fire,[3] sound strategy and commonsense tactics.

Owing to the situation, which had become extremely grave, General Naulin was recalled from a cure at Vichy about the middle of July to assume command in Morocco. In an interview[4] he stated that the Government had provided him "with all material means he required, but

never been used to any great extent as an ambulance owing to the difficulty of finding adequate landing space near the Front." (*Morning Post*, 28. 10. 1925.)

[1] *The Times*, 25. 5. 1925. [2] *Ibid.*, 21. 7. 1925.

[3] The Riffs formed their anti-aircraft defence by several rows of men lying on their backs and taking aim at the flying enemy. (The *Morning Post*, 21. 10. 1925.) [4] *Petit Parisien*, July, 1925.

what was wanted was an abundance of infantry—and good infantry. There was nothing better in war than capturing and holding a position.[1] Artillery and the air force were only accessories." He disclosed that there were already 125,000 men in the Riff, and that forty battalions more were to be sent. Later it was officially stated that the total French losses (killed and wounded) in the war against the Riffs, up to 15th October, 1925, were no fewer than 10,473. Monsieur Painlevé stated, on 21st October, that the cost of the French campaign in Morocco up to date was estimated at £8,700,000.[2] The expenditure caused to Spain by Morocco during the last few years is said to be £18,000,000 per annum. In the Spanish zone it is not probable that there are more than half a million Moors; therefore, each Moor, man, woman, or child, is costing the taxpayer £30 per annum.[3] The Spanish losses in killed and wounded, which must be considerable, have not been published, but the casualties at Alhucemas alone were stated to be between 4,000 and 4,500.[4]

In view of the opinion expressed by the Air Chief Marshal Sir Hugh Trenchard that the result of a war would be determined by the relative number of aeroplanes on each side, it is remarkable that after hostilities of many months the result of the war was still inconclusive, and that the campaign was spoken of in France as the "Moroccan nightmare."[5]

Concerning the use of aircraft in war, air advocates were asked at the American Inquiry in September and October, 1925, why, "with all their superiority in the air, France did not conquer Morocco." Major-General Patrick, Chief of Air Service, U.S.A., said "that was a question he had asked himself rather frequently; for

[1] "Aircraft by their very nature cannot hold a position once taken." (Brigadier-General Drum.)

[2] *J. of the R.U.S.I.*, November, 1925, p. 764.

[3] *The Times*, 25. 11. 1925.

[4] The *Morning Post*, 31. 10. 1925.

[5] *Ibid.*, 17. 9. 1925.

one thing, it was probably due to the character of the warfare. It was guerilla warfare carried on by individuals who hid behind trees and rocks and could not well be sought out. Another thing, the French have not concentrated any considerable air force in Morocco until right now" (end of September, 1925). "Why they had not done so, when by using aeroplanes they could end the war, was difficult to understand."[1]

Commander Bellinger (U.S. Naval Air Service) gave his theory: "I do not think the objectives in Morocco are proper air efforts. I think they are not the kind of objectives that would show up for aviation. It is very difficult, I think, to determine a man from a rock over there."[2]

Mr. Curtis Wilbur, Secretary of the U.S. Navy, brought forward at the Hearings before the President's Aircraft Board[3] the report of General Niessel, Inspector-General of the French Air Service, *made in July, 1925*, and furnished to the U.S.A. in the usual exchange of information. It is as follows:

> "In Morocco we have a state of war—actual war. Again, the country is most unsuited to air service operations—rough mountainous country that is broken and largely covered with vegetation, affording excellent cover. The targets are few, the Riff having no great bases nor industrial centres, and never concentrating his forces, as we saw on the front during the Great War. We bomb his villages, but it does not prevent him from going out and firing a rifle; we can shell villages too, yet the soldiers are not so filled with terror that they stop fighting. Artillery—yes; they have artillery, but it is not strong nor especially efficient.
>
> "*As to our air force*, we have a fairly large proportion of aviation in comparison with other arms,

[1] "Hearings," pp. 84, 85. [2] *Ibid.*, p. 875.
[3] Known as "The Morrow Commission."

fourteen squadrons are operating in the north Moroccan front. As to the airplane as an 'independent agent of warfare,' it is not. The air force is an auxiliary arm; we might say the 'fifth' arm. The air force cannot operate independently, no more than the artillery. We must have infantry to advance and occupy the ground. *The powers and possibilities for the employment of an air force have been exaggerated.*"[1]

Field-Marshal Sir W. Robertson, discussing the British Army manœuvres and the use of aircraft in war, referred to "those air enthusiasts who assert that the next war will be decided in the air before a ship or battalion can leave home ports—an assertion, by the way, which has received no confirmation from the extensive air operations of the French in Morocco."[2]

The offensive operations against the Riffs had been suspended in the late autumn on account of the weather conditions, and a large number of the French troops withdrawn to winter elsewhere. In May, 1926, hostilities were recommenced. The experience of the campaign of the previous year, though dearly bought, was turned to good account by France and Spain. General Naulin's insistence on the necessity of infantry to enable positions to be taken, and when taken, held, and his assertion that aeroplanes and artillery were only accessories, bore good fruit. The application of the first principles of warfare, aided by the necessary men, compassed the final and speedy overthrow of the comparative handful of native tribesmen, great as was their courage and their skill. No one who followed the final stages of the Moroccan campaign could have failed to notice the almost total eclipse of the aeroplane as a weapon of war, though aeroplanes performed a useful service as emergency transport for plenipotentiaries to and from the abortive peace parleys.

The Moroccan War started in 1921. For five years

[1] "Hearings," p. 120. [2] *The Morning Post*, 28. 9. 1925.

aeroplanes were employed against an enemy possessing none. This provides a striking commentary on the 'Power of the Air.'

Turning to Syria and the ancient town of Damascus, where the French, under the Mandate of the League of Nations, are in occupation to maintain law and order, there is perhaps an even more noteworthy reflection on Sir Hugh Trenchard's forecast of air warfare. A stupid mishandling in the summer of 1925 of a simple Druse grievance furnished the spark to the general discontent, and a Druse chieftain stated that the aerial bombing of a village gave the signal for a general outbreak. As a reprisal for the loss of two columns with all their train, which included ten aeroplanes—

> "the French aeroplanes dropped tons of explosives upon the Druse villages, killing eighteen men and numerous women and children. This resulted in stiffening the revolt, while the Bedouins from the neighbouring deserts are coming in to join the Druses. Six aeroplanes have been shot down, and two pilots are prisoners. The Druse armament is poor, consisting of a miscellaneous collection of German, Turkish, French and British rifles. They are without machine-guns, except those they have captured."[1]

The total French losses in Syria (killed, wounded, and missing) from the beginning of the campaign to July, 1925, was officially given as 6,041.[2]

Sir Hugh Trenchard's belief that nothing else could finish a war so quickly as lowering the *moral* of the enemy by an active air offensive, is shared by Lord Thomson, who asserts that "an Air Force carries war into the heart of the enemy's territory with appalling swiftness and effect; thus it is better calculated to break down the hostile nation's power of resistance."[3] But the

[1] *The Times*, 10. 8. 1925.
[2] The *Morning Post*, 15. 10. 1925.
[3] Special article to the *Sunday Times*, 14. 3. 1926.

aeroplane bombing of Druse villages only incensed the native tribes, and the villagers being burnt out of their homes formed themselves into brigand bands and conducted a harassing guerilla warfare. The French were in a vicious circle. They bombed and burned villages believed to have harboured and aided the rebels, and thus drove the ruined inhabitants to the rebel ranks.[1] Early in October the French shot 100 "brigands," bringing twenty-four of the corpses on camel-back to Damascus to expose them in the Marghi Square. This was intended "as a warning to the turbulent element; it had, however, an entirely opposite effect, for it merely served to infuriate the populace and accentuated the feeling of irritation already abroad," and led to the raid on Damascus on 18th October,[2] and this in turn to the French reprisals, when "at midday, tanks were sent through the City, passing along the Bazaars at a terrific speed, firing to the right and left without ceasing, and later this old City was bombarded for more than twenty-four hours by artillery outside the City and aeroplanes dropping bombs and using machine-guns."[3] As a result the Syrian situation became graver than ever, the 'brigands' grew more numerous every day as more villages were destroyed,[4] public security ceased, law and order vanished. The new strategy, "control without occupation,"[5] had proved disastrous, and the prestige of European Powers was dangerously imperilled by the employment of and dependence upon offensive methods as ineffective as they are extravagant and barbarous.

The experience in Morocco and Syria must have dis-

[1] *The Times*, 31. 8. 1926.

[2] "This was the reply typical of the spirit of those whom it was intended to intimidate." (Special Correspondent of *The Times*, 27. 10. 1925.)

[3] *The Times*, 27. 10. 1925.

[4] The *Morning Post*, 4. 11. 1925. "Many of these are rebels by compulsion more than desire. They have lost all their belongings except the clothes they are wearing." (*Morning Post*, 9. 11. 1925.)

[5] Sir Samuel Hoare's phrase, *J. of R.U.S.I.*, November, 1925, p. 652, and *Flight*, 24. 12. 1925, p. 833.

appointed the ardent advocates of the military value of the Air, for the French authorities have admitted that the grave situation in Syria, as in Morocco, was brought about by the lack of good infantry. Large reinforcements were in consequence dispatched to the East, competent authorities stating that in their opinion nothing short of 40,000 men would suffice.

Early in 1926 General Sarrail was superseded by M. de Jouvenel. Terms of settlement were attempted but a hitch occurred. By April the French had 40,000 troops in Syria, and 15,000 men were concentrated at the bases, prepared to seize and occupy the Druse capital. In Damascus alone there were 10,000 French troops, and it was stated that any considerable weakening of the Damascus garrison would be the signal for the rebels to attempt to capture the city. "It is common knowledge that the Damascus-Beyrouth railway is continually cut, also that the line Damascus-Deraa and roads leading to Damascus are impassable."[1] Early in May Damascus was again bombarded by artillery and aeroplanes, but the revolt was not checked, and recrudescence of fighting took place.

> "It flourishes on its own harvest of economic ruin which has produced an anarchical state of mind."[2]

Shooting at civilian aeroplanes and burning alive captured French airmen, with their aeroplanes, showed the bitter feeling of hatred and revenge which the indiscriminate bombing by aircraft inevitably kindled.

At the end of June, 1926, according to a French official communiqué, further detachments of troops sent to Syria as reinforcements were being disembarked at Beirut. Faith in the 'power of the air' had dwindled to vanishing point. Infantry and more infantry was the pressing need.

A pause occurred in the hostilities—the Syrians petitioned the League of Nations to be allowed to present

[1] *Morning Post*, 19.4. 1926. [2] *The Times*, 1. 6. 1926.

their own case at Geneva. M. de Jouvenel had apparently underestimated the resources and determination of the revolutionaries. Another High Commissioner, M. Henri Ponsot, was appointed to solve the difficult problems which confronted the Mandatory Power, for wide discontent had followed economic ruin. Druse bands still kept the field in the Hauran, and the state of parts of Syria was by no means satisfactory.[1] Skirmishes still took place with success on one side or the other. M. Ponsot had a narrow escape from capture in an attempted ambush. "Rebels" were posted in the environs of Damascus, and in a big skirmish at the beginning of November the French withdrew to Damascus with fifty casualties; later a General Council of Druse Skeiks met to discuss peace terms. M. Ponsot had offered separate liberty to the Jebel Druse. They insisted however on the unity of Syria.

Towards the end of November it was at last reported that an armistice had been concluded between the French and the Druse for the purpose of discussing terms of peace. "There now appears every prospect of the war coming to an end."

[1] *The Times*, 8. 10. 1926

"*A nation's institutions and beliefs are determined by its character.*"—HERBERT SPENCER.

CHAPTER XIII

THE DEFENCE OF LONDON AND ANTI-AIRCRAFT GUNNERY

THERE can be little doubt that constant reiteration has generated a widespread belief and a fear amounting in many cases to terror, that "the next war may bring down upon London, and other centres of population within striking distance of a possible enemy, devastation and utter ruin from the air; that a future great war can only result in unprecedented horror and misery, and probably in the destruction of the civilised world."[1]

Air enthusiasts affirm that the only way of escape from such a fate is to be found in the possession of an Air Force "supreme in the air."

It has been shown that there are few points on which air enthusiasts agree: incongruously enough there is agreement on the part of all responsible authorities, including the Air Chief Marshal Sir Hugh Trenchard, that an Air Force is impotent to defend the country against air raids. This opinion is held by some members of the House of Commons. In the Debate on the Air Estimates, 1926-1927,[2] many pertinent questions were asked regarding the intended employment of the Air Force in the event of war, and whether any Air Force was really adequate as a means of defence against an attacking Air Force:

> "I wanted to hear what he (the Secretary of State for Air) would say about the Air Service as a means of defence for this country . . . in view of the fact that the chief use of air machines in war is to consist of deliberate attacks on defenceless populations, I think it would have been appropriate if the Air

[1] Major-General Sir F. Sykes, in *Edinburgh Review*, October, 1925, p. 383.

[2] *Parl. Debs.*, 25. 2. 1926 and 8. 3. 1926.

Minister were to make a frank statement to the House, and say what is the value for defensive purposes of the Air Service to the British nation in any conceivable circumstances of modern war. The opinion is growing, and is fortified by expert views, that we are simply playing a fool's game." (Mr. Rennie Smith.)

"We are discussing this Air Vote to-night, and the defence of the Minister in regard to that Vote is that it is providing the people of this country with security in the air. That is his main line of defence. Obviously, if it is not providing the people with security, there is no justification whatever for bringing the Vote forward. If it is not going to do that, he is deceiving us and the country, and is getting his Vote by false pretences. Is he going to provide us with that kind of security? . . . If we are not going to meet that situation the whole justification for our air policy falls to the ground." (Mr. Thurtle.)

"What is the rôle of the Air Force in defence? How much of the burden of defence of these islands is now carried by the Air Force? It must be something: it cannot be that the Air Force is doing nothing in defence." (Major Hills.)

"The Minister gave us four objectives of the Air Force, and he said—and I think we shall all agree with him—that by far the most important was its position as a home defence force, but I think Members will have noticed that throughout his speech he said very little indeed about defence. The only reference I found at all with regard to the functions of the force for defence was a rather haphazard reference to bombs . . . and it seemed to me that what he really meant by a home defence force was a counter-attacking force, for an Air Force is not really a defence force at all . . . I am profoundly sceptical as to the value of what is called air defence." (Major Attlee.)

And speaking of the increase in the Air Estimates, Major Hudson stated:

> "This increase is to be provided under the apparent delusion that it is to secure the defence of the country. The Right Hon. Gentleman insisted that this was the first duty of the Air Force. No one knows better than Members of the Government, particularly the Chancellor of the Exchequer, that if ever the contingency arises in which these so-called weapons of defence are required to be used, you might just as well have armed the people with sticks and stones from the point of view of any effectiveness that will be obtained. That is the charge that we make against the Government in connection with the Estimates now put forward. The Committee is engaged in a sorry game of make-believe."

Replying to these serious assertions and searching questions the Secretary of State for Air said:[1]

> "Air Defence is one of the most difficult problems that has ever presented itself in the field of national defence. It creates a series of new and almost insoluble problems, and it may be that however efficient your air defence is, you can never make it impossible for an attacking force to penetrate these shores . . . in the event of war . . . we shall apply the Air Force in the best way possible in order to bring the war to an end and beat the enemy."

While the Secretary of State for Air appears to be in grave doubt as to the methods and means by which air power can well be applied in war, he seems quite confident as to the value of aircraft for commercial purposes. Presiding at the inaugural lecture of the Air Ministry

[1] *Parl. Debs.*, 8. 3. 1926.

Students' Classes on "Trade and Travel in the Middle Ages," he stated:[1]

> "already there were sufficient signs to show that air communications were destined to play an important part in the development of trade";

and he went so far as to foreshadow a surprising activity for the Air Ministry of the future:

> "the Air Ministry might be the Department concerned in the trade and travel of the world."

In sharp contrast to these beliefs Sir Alan Cobham, in no way intimate with great strategical questions but the great trade pilot, does not consider aerial transport a paying proposition, and actually stated: "commercial success is not the issue."[2] In his opinion the *raison d'être* of long-distance flights and the development of aerial routes, and all that this implies, is the defence and safety of the Empire.

An extraordinary spectacle is thus presented. A Secretary of State for a fighting service, while lukewarm and uncertain as to the military rôle of the Air Force for which he is responsible to Parliament, is enthusiastic and confident as to the commercial future of the air. On the other hand, the greatest long-distance commercial pilot, convinced of the futility of aeroplanes for commercial undertakings, is confident of their military value for the defence of the Empire.

Air Chief Marshal Sir Hugh Trenchard frankly admitted in his lecture at Cambridge that the aeroplane was "a shockingly bad weapon of defence against an aeroplane"; that it was in fact "an offensive and not a defensive weapon."[3] This was clearly demonstrated in the late War:

> "Everything had been done by our planes to prevent the enemy planes from asserting themselves,

[1] The *Morning Post*, 12. 10. 1926.
[2] The *Melbourne Argus*, 16. 8. 1926.
[3] *The Times*, 30. 4. 1925.

> but here, time after time, is shown the activity of the enemy planes. They could not be stopped."[1]
>
> "The impossibility of preventing single machines or even all hostile patrols from crossing the lines cannot be realised without comprehending the immensity of the air and the difficulty from the air of seeing other machines in it."[2]
>
> "The idea that the possession of a strong air force, as of a strong fleet, is a guarantee of security was dealt with and refuted in a memorandum which was drawn up by the British Air Staff in France in September, 1916. This memorandum points out that the aeroplane is an offensive and not a defensive weapon, and that it is utterly impossible to prevent hostile machines from crossing the line 'simply because the sky is too large to defend.' This, it states, is the inevitable consequence of having to fight in three dimensions."[3]
>
> "No nation, however powerful its air forces and anti-aircraft defence, can hope to safeguard absolutely its homeland from the raids of the enemy whose air strength is not negligible. There can never be in the air that sure line of defence for an island nation which a powerful fleet constitutes at sea."[4]

In short, no matter how many millions are expended on our Air Service, how many pilots are available and fit to fly, and how many single fighters or bombers are on charge, immunity from bombing attacks cannot be ensured by this means—"the space of heaven cannot be closed."

Notwithstanding, on 26th June, 1923, the then Prime Minister, Mr. Stanley Baldwin, set forth the principles

[1] From Fifth Corps (U.S.A.) Intelligence Summary, Meuse-Argonne Sector, quoted by Maj.-Gen. Summerall, "Hearings," p. 1225.

[2] Squadron-Leader B. E. Sutton, *J. of the R.U.S.I*, February-November, 1922, p. 343.

[3] Quoted in "Air Power and War Rights," p. 26.

[4] "Air Power and War Rights," p. 25.

on which British air policy was to be based. He gave an assurance that British Air Power should, in addition to meeting the essential requirements of the Navy, Army, and Indian and overseas commitments, include "a home defence of sufficient strength adequately to protect us against air attack by the strongest air force within striking distance of this country." The Labour Government which followed entirely endorsed this policy. But it is clear that the Air Ministry fully realise that London, or any large town, cannot be defended by aircraft; it is equally apparent that they consider bombing of enemy towns a procedure in war which should be adopted, for the preparations to this end are frankly disclosed; indeed the Air Chief Marshal, cognisant of the fact that the aeroplane is a shockingly bad weapon of defence against the aeroplane, stated his considered opinion on the Air Force as a means of defence thus:

> "Although it is necessary to have some defence in order to maintain the *moral* of our people, it is far more necessary to lower the *moral* of the enemy people, for nothing else can end war."[1]

The scheme for the Air Defence of London has been outlined. The Regular Air Force for Home Defence, with single-seater fighters to ward off hostile attacks by engaging enemy airmen, and with bombers for attack and counter-attack on enemy property and territory,[2] are to be aided by the Auxiliary Air Force. This Force, on the lines of the Territorial Force, is composed of squadrons all intended to be bombing units, and the Air Ministry has granted to the County of London

[1] Quoted in *Parl. Debs.*, 25. 2. 1926.

[2] It is suggested that huge day and night bombers will assemble at the declaration of war to penetrate into the enemy's country for the attack on his centres of population, his mobilisation zones, etc., and "the asphyxiation of a large enemy city" appears to be contemplated. ("Aviation in Peace and War," pp. 101 and 103.)

Squadron a permit to wear a badge specially designed for them by the College of Heralds.[1]

Air Commodore J. G. Hearson states:[1]

> "Every officer and every airman undertook to be at his post at the first threat of air invasion,[2] and to set out on bombing expeditions,[3] described as 'the points of departure and of intended return of which, were in this country.'"

These bombing expeditions consist of flights "to Europe and back to the home station,"[4] unless the Territorial is killed or brought down on enemy territory,[5] for these Territorial Air Squadrons will only be sent on flights "starting and ending at a home base."

While the "Auxiliary Air Force for Home Defence" is off on bombing expeditions elsewhere, the real defence of London against enemy airmen will not be the duty of the Air Defence Forces of the Air Ministry, but will be undertaken by the Territorial Army (Air Defence Brigades, Royal Artillery, and Royal Engineer Units under the War Office),[6] whose duty in the event of an attack is to engage with gunfire, aided by searchlights, the enemy bombers that may find their way to London. During the debate on the Air Estimates, 1926-1927, Lieut.-Colonel Heneage, referring to this anti-aircraft defence, said:

> "Those weapons are not weapons of offence but of defence, and for that reason the East End of London

[1] *Flight*, 21. 1. 1926.

[2] 'Raid,' and not 'invasion,' is clearly meant. (Admiral D. T. Norris, C.B.).

[3] By the same token, immediately on the outbreak of war, the Royal Navy (a true mobile force) should proceed to subject every undefended town and village on the enemy coast to a hail of high explosive, incendiary and poison shell.

[4] *Parl. Debs.*, 14. 4. 1926.

[5] It is officially stated that in 1918, 483 hostile planes were directed on Paris; "of these 483 hostile planes only 37 got to Paris and 13 of those 37 never returned to their lines." They were brought down by the anti-aircraft defences. ("Hearings," pp. 1280 and 1354.)

[6] *Parl. Debs.*, 8. 3. 1926.

ought to be encouraged to take an interest in this part of our air defence. After all, it is air defence,[1] although it is actually manned by the Army. I am aware that possibly on the outbreak of war it would be transferred to the Air Force, but it is not fair to the House or to the men themselves that they should be trained and manned by one Force and changed over on the outbreak of war. It is not fair to us, because we are dealing with the Air Estimates, and we have to consider the Army Estimates."

It must be clearly understood that the citizens of London and elsewhere in this country cannot legitimately complain if subjected to bombing from aircraft—the new method of warfare—since it is intended *on the outbreak of war* to send out from this country members of the Auxiliary Air Force for Home Defence to bomb enemy property and territory; in truth it may be said that we invite bombing attacks by such definitely provocative intention and preparations.

If the enemy is a great and civilised nation with air forces, "a hideous cycle of strokes and counter-strokes is opened up." There is in fact complete reversion to barbarism. If sabotage is recognised as legitimate warfare, the corresponding attitude of mind must prevail, and means long since discarded as beyond the pale of civilisation may well be revived. If aerial bombs are to be used against the civil population and 'frightfulness' recognised, the nation must logically object to 'frightfulness' being the prerogative of one Service only. The haphazard achievements of 'air power' can easily be surpassed in terror by the Army and the Navy to whom such practices have hitherto been alien, and which have been expressly repudiated by the Royal Navy.

Evidence has been given to show that aerial bombing has proved a dismal if not humiliating failure, and that

[1] The commitments entailed in this defence of London against air attack are included in the Army Estimates.

it is not only a reversion to barbarism, but is utterly futile in helping to win the war. But we still officially believe in bombing. We have carried out in Waziristan an intensive bombing campaign, and we are not supporting the United States of America, Japan, Italy, and the Netherlands in their efforts at The Hague to prohibit, as a Rule of Warfare, without any qualification, aerial bombardment of towns and villages, the injuring of non-combatants, and the destruction of private property.

The nation now seems to take frightfulness as a matter of course. This being so, it is very difficult to understand the continuing attitude of indignation against our late enemies, and the condemnation passed by men and women of this country on such acts as the bombing of London and other towns during the late War, resulting in the killing and maiming of women and children; or of the submarine campaign and the sinking of the *Lusitania*. Is execration of 'baby killing' and all that it implies, hypocrisy? Is there a moral distinction between the killing of British women and children by the bombing of London and the recent bombing of totally defenceless women and children in their native villages in Waziristan for which Distinguished Service awards have been given? During the Debate on the Air Estimates in March, 1926, Mr. Viant said:

> "We have no right to harass these poor defenceless creatures under circumstances of this kind. . . . Then, by way of recognising the special merit of killing these defenceless people, to give Distinguished Service Medals for this purpose seems almost beyond anyone's imagination."

It is significant that the House of Commons was silent and no explanation or justification of this conduct was attempted by the Ministry concerned.

"Countless times in past history inventions have been made and perfected which have been heralded as being the means of ending warfare. The mine, the torpedo, the

submarine, the balloon, have all been predicted as the end of navies or armies, but in every case a counter has been devised and the new weapon has become merely an arm of that Service it was originally intended to replace. So it is with the aeroplane."[1] "The unfavourable balance created by the sudden development of the aeroplane has threatened for the moment to destroy the security of inland cities and upset the steadying influence of sea power. This unfavourable condition is only temporary in the opinion of those most familiar with the development of ordnance. They believe that modern artillery, when properly set and controlled, is of sufficient power and precision to control the air around the points it is defending. Artillery can fire far higher than any aeroplane can fly, and can shoot with a high degree of precision when there is time to set the fire control adjustments accurately and carefully. The problem is chiefly a matter of developing automatic machines which will control the routine adjustments instantaneously and with mechanical precision, and eliminate the time lost and errors of many hands."[2]

No anti-aircraft artillery was in existence prior to the World War, and this had to be improvised and developed from such material as was available. Notwithstanding the crude anti-aircraft guns and instruments, one-fifth of all the planes destroyed by France, Italy, and Germany were brought down by anti-aircraft fire,[3] and the point is noted[4] that there was a very rapid increase in the effectiveness of fire notwithstanding the improvement in the speed and the ceiling of aircraft during that time.

Speaking of anti-aircraft fire, Captain Rath, U.S.A., said:[5]

> "We were warned by the English never to go over the City of Metz because anti-aircraft was very

[1] "Hearings," p. 168. [2] *Ibid.*, p. 1699.

[3] 2,149 planes were brought down by these three countries. For the *full* value of anti-aircraft fire, *vide* p. 230, para. 2.

[4] "Hearings," p. 1353. [5] *Ibid.*, pp. 1107-1110.

active and accurate there. Therefore we would avoid the towns and fields where we knew they were."

"We avoided as much as possible anti-aircraft batteries. As soon as we discovered batteries we left them alone and went around them. Certain cities that we were trying to bomb continuously, like the real centre of the Briey iron centre, were heavily protected by a barrage of anti-aircraft."

"There is all the difference in the world between pursuit and bombing planes. The bomber has an objective to go to, and he must go on a straight line. . . . At a place where the Germans had a big battery . . . as soon as we would get going along there, as soon as they would get our altitude and direction, they would correct all of their other guns immediately."

"They knew we were going to bomb Conflans. They knew about what our altitude was, and they knew about the time we got over the lines. And their anti-aircraft got on to us as soon as we got over the lines. They would watch their fire, and quickly correct their altitudes. . . . Here is a picture which shows how they are correcting it . . . you will notice they have our altitude practically and are creeping up. That is about 2½ to 3 miles in the air. . . . As soon as you have shot and got your 'over' or 'short,' whatever it is, why then you fire a volley of the whole battery. That is what the Germans seemed to do, and with great effect. They did bother us. For instance, we might get to the objective, but as soon as we got there they would throw up a huge barrage and it would have a tendency to break up our formation. The smoke would be so thick we could not see our formation."

Captain H. C. Boys, Royal Artillery, considers the attack on aeroplanes by gunfire to be in the nature of "a driven partridge" question. This analogy is

obviously not meant to be exact, but it rightly indicates the general nature of the problem.[1] It seems clear that just as after the introduction of the gun the trained falcon was no longer loosed against its quarry (except perhaps for sport), so the aeroplane, loosed against another aeroplane, must yield to the same weapon—the gun—specifically developed for aerial defence. For defence against aerial attack the world has hitherto relied largely on counter-attacks by aeroplanes. "This means matching man for man and plane for plane at terrific cost. As the matching of aeroplane against aeroplane may go on indefinitely, *such a system of defence is inherently unstable.* A tendency towards stability of affairs is introduced only when the cost and risk of the defence is less than that of the attack."[2]

It has been shown that there is only one spot in the heavens, at a given level and on a given course, from which a bomb can be dropped to hit a specific target. Consideration of the matter[3] shows that there is a definite aerial danger zone above small fixed targets on land and ships at sea, that ships carry their zone with them, and that their anti-aircraft guns can therefore be trained on, or just outside, that part of the zone to which the bombers are seen or heard to be approaching.

Very great importance is attached to anti-aircraft by the U.S.A., for the anti-aircraft gun "is a weapon which is always on the spot, which is never out of commission,

[1] *J. of the R.U.S.I.*, February, 1926, p. 61.

[2] "Hearings," p. 1699.

[3] Assuming that an aeroplane can approach from any part of the compass, the one spot for any one direction becomes a ring of spots for all possible directions of approach. The diameter of this ring of spots is affected by the speed of the aeroplane; the position of this ring is directly governed by the height at which the aeroplane is flying. Since the speed of bombers when loaded can only vary between narrow limits, the area enclosed in the ring is comparatively constant. It would seem to the lay mind that attack of the aeroplane by gunfire does not present great difficulty and that the fire should not be directed upon the oncoming aeroplane, but over a zone outside or on the circumference of the ring.

and which will furnish very effective protection against a bombing plane seeking to reach a small definite object";[1] indeed it was stated at the Hearings that "the Air Services of the Army and Navy are devoting as much attention to anti-aircraft defence as to aviation." Rear-Admiral Hughes stated: "We are carrying on experimental work all of the time as to method, and the bureaus are furnishing us new instruments. Anti-aircraft gunfire is advancing faster than is aviation."[2]

The defence of ships against aircraft is doubtless receiving attention from the Royal Navy, but in any case the defence of ships and definite objects is comparatively a small matter, since the risk they run from bombing aeroplanes is, as has been shown, negligible. The question of the defence of cities, particularly such a city as London, is a totally different matter.

Objectionable as it is to speak of a great and friendly country in such a connection, it cannot be overlooked that no country except France can seriously threaten London from the air. It is true that bombing aeroplanes might reach London and return to German territory in favourable weather, but the journey is great—this means much fuel, few bombs, low altitude and flight across neutral if not hostile country. The approach of bombers to London must be over a comparatively narrow sector, thus simplifying the concentration of defence. The bombers may be met near the coast by fighting aeroplanes – though it must be said there are grave objections to the employment of aeroplanes for anti-aircraft defence—moreover, as the French found in the defence of Paris, the co-operation of aviation with artillery presented great difficulties and even dangers. It became quite difficult to recognise the nationality of the planes in the field of fire; also sound ranging on which the fire was based was seriously hindered. The batteries were also delayed in opening fire.[3]

[1] "Hearings," p. 1140. [2] *Ibid.*, p. 1025.
[3] *Ibid.*, p. 1354.

The defence of London must consist of powerful artillery specially developed and suitably placed for the attack of bombers, comparatively low-flying and slow-flying machines, and if in 'bombing formation,' flying along a straight line. These anti-aircraft defences can be developed year by year; they will be permanent and will require few personnel for maintenance; battle practice against fast-moving targets would form the training of the anti-aerial defence forces of the Territorial Army.

"While the mission of the anti-aircraft artillery is to destroy enemy aircraft, its effectiveness is not judged alone by the number of enemy planes that it may bring down, but rather by its success in limiting and hindering the enemy aerial activities within effective range." The efficiency of anti-aircraft artillery over and above the infliction of casualties may be measured by its ability to disturb the aviator, to force him to change continuously his course and altitude, and to require him to fly so high that he will be beyond the range of good visibility.[1]

No material defence can be arranged to prevent a hostile machine from coming over British territory, and it is not intended to imply that some machines would not pass if the attempt were made; but with proper anti-aircraft defence casualties would be high and the gain disproportionate. It may truly be said that the vast spaces involved, the relatively trifling amount of gas or explosive that can be carried by air, the almost absurd ineffectiveness of unconfined explosions, all render aerial bombing perhaps one of the most ineffectual and expensive means of accomplishing material destruction.

Bearing in mind the tremendous cost of the maintenance and employment of 'air power,' and the nature and relative unimportance of air warfare, there appears to be for this country one clear and appropriate line of action. While developing *natural counters* (both passive and active) to enemy aircraft, Britain should declare that under no circumstances whatever will she take part

1 "Hearings," p. 29.

in or sanction the aerial bombardment of towns and villages, a declaration tantamount to the surrender of the practice of bombing and consequently of the construction of bombing machines. While surrendering this barbarous and relatively futile weapon[1] Britain should take back her full right of blockade,[2] that *potent, non-destructive, and lawful* weapon which broke the power of Napoleon. The failure to use this mighty attribute of sea power in the late War must be held responsible for the holocaust on the battlefields of Europe—a holocaust fed and sustained for years through the seven seas in the face of our Fleet. The prevailing belief in so-called *air power* seems to have banished our former inbred understanding of what sea power[3] can mean—its active, mobile and potential force and domination. It is inevitable that this faith in air power must profoundly influence if it does not actually govern our present foreign policy. Indeed, a cursory examination of recent treaties reveals that a fear of aeroplanes and submarines has undermined our immemorial trust in surface vessels, and is responsible for the apprehension that the Channel is no longer England's natural frontier and defence. Sea power

[1] During the *four* years of War there were 51 Airship and 52 Aeroplane attacks over this country. London was bombarded 12 times by airships and 19 times by aeroplanes. The total number killed in Great Britain during the whole period was 1,413. In the *four* years 1922-25 inclusive, the number killed in street accidents in England alone was 11,346.

[2] This right was voluntarily surrendered by the Treaty of Paris, 1856. The resumption and exercise of full maritime rights would make unnecessary for this country the creation and employment ever again of an expeditionary army of Continental proportions. The alternative to a bloodless blockade by sea in 1914 was the land siege of a great military Power by a vast army, resulting in the awful slaughter that such a siege must entail. This subject has been exhaustively treated by G. F. S. Bowles in "The Strength of England."

[3] Sea power does not imply a 'bloated Navy.' It does mean a strong Navy of great radius of action and sea-keeping capacity—a Navy planned for *any* eventuality and not for a particular one. A reserve of strength will always lie in our great sea-faring population and matchless shipbuilding resources.

in the past has been the warp and woof of our foreign policy.

Belief in the decisive nature of *sea power* undoubtedly, and perhaps naturally, has been shaken by two factors in the late War: firstly, the lack of authority to exercise the power of full blockade; secondly, by the devastation wrought by German submarines on our Merchant Marine, notwithstanding the complete mastery of the surface of the sea held by our Fleet. The first is within our power to reclaim. The second can never recur, since as the War progressed *Convoy* proved itself to be the true and decisive counter to submerged attack on commerce. Those who believe that bombs should be met by bombs may reflect that it is easily within the power of the Navy to subject the coastal towns and villages of the enemy to a bombardment of terrible dimensions. It is certain that the tremendous power of naval guns could act as a powerful, if not decisive, deterrent to any nation that contemplated the dropping of bombs on British soil, though it is far from certain that the Royal Navy would consent to be made the agency of such a form of warfare.

It may be argued by other nations that any aeroplanes that we possessed, not distinctively bombers, could be used for the purpose of bomb-dropping. It may be pointed out that the primary function of aeroplanes is bombing, and except in so far as other types of planes assist bombers their uses are subsidiary, and this being so, the construction of aeroplanes as weapons of war by this country, irrespective of what other nations may elect to do, could be abandoned without endangering our position in war, and with an enormous economic advantage, in itself one of the mainstays of security.

Aerial warfare is closely connected in the public mind with poison gas and bacteria. Gas warfare should not be reprobated on the ground of inhumanity, for in point of fact its effects may be less horrible than those caused by explosives; in fact the reason for emitting into the atmosphere the trifling quantity of gas that an aeroplane

can carry instead of dropping high explosive or incendiary bombs is not clear. Mr. Baldwin evidently believes in the potency of gas attacks, bomb-dropping, and 'scientific warfare'[1] generally, for he stated in his presidential address at the annual meeting of the Classical Association on the 9th January, 1926, that—

> "one more war in the West, and the civilisation of the ages will fall with as great a shock as that of Rome."

Since the Government believes in gas warfare and warns the country of its horrors, it is not surprising that attention is being directed to the matter. The Air Minister has been urged to supply every man, woman, and child with a respirator and to arrange for instruction in its use. Furthermore, Air Ministry experts working in conjunction with 'scientists,' are making a close study of chemical warfare. It would be of interest to know how far the Chemical Combine in this country is in a position to influence policy either indirectly or by direct representation on the Chemical Warfare Committee. This point is of importance in view of the activities of the National Association of Chemical Defence—a private organisation of chemists and manufacturers in the U.S.A.—who, it is reported,[2] by pressure or influence have deflected the Government from their original attitude towards the use of chemicals and gases for military purposes.

The Air Ministry busy themselves with the problem of protecting London and provincial centres against gas attack by enemy bombing aircraft. It is understood that in one of the plans suggested, certain rooms in every house or public building are to be "gas-proofed."

[1] When the truth emerges, as it must do eventually, it will be found that 'science,' so far from contributing substantially to the winning of the War, brought this country within an ace of losing it, and is directly responsible for a large and unnecessary portion of our National Debt.

[2] *The Times*, 15. 12. 26.

Another scheme is to provide large gas-proof underground shelters of several storeys built beneath the city squares and other public spaces. The organisation of gas-fighting battalions of helmeted and masked men carrying spraying appliances with which to dissipate the gas clouds in the streets, and the planning of machinery for the speedy evacuation of a large proportion of the urban population to the countryside, are also being studied.

These and even more fantastic remedies and schemes are the natural result of fantastic ideas of 'air power.' Only in the pages of Swift and in the laboratories of Lagado can be found the parallel of such projects and the elaboration of such schemes. The true case against gas, as against all *freak warfare,* is fortunately based on futility:[1] to produce and transport by aeroplane a volume of gas that is anything but insignificant in comparison to the vast spaces to be dealt with, requires an effort and outlay out of all proportion to the advantage that may, with extreme good fortune, be obtained.

"Nothing is terrible except Fear itself." Surely this great nation can bring its traditional sense of perspective into play, and by examining the matter in all its bearings with dignity and composure cease to be controlled by Interests[2] and governed by Fear.

"All the arms of England will not arm Fear."

[1] Gas attacks against small sectors of the Front in the late War were an entirely different matter. Vast preparations were made in advance. Surprise was essential to success. After the early attacks the menace was satisfactorily countered by both sides, though at the cost of considerable discomfort and great inconvenience.

[2] Readers can hardly fail to perceive the far-reaching, interlocking, and powerful influence of Scientific Pools and Salaried Bureaucrats, of Wireless, of Oil and the Aircraft Industry. In *The Times* (14. 1. 26) it is stated "the Air League of the British Empire has received an offer, on behalf of those interested in production, of £5,000 for two years under certain conditions, this sum to be used in organisation and propaganda. One of the conditions, it is stated, is that their nominee should be appointed as Secretary-General at a salary of £2,000 a year including expenses and should have a free hand."

"*There is only one way of seeing a thing rightly, and that is seeing the whole.*"—JOHN RUSKIN.

CHAPTER XIV

AIRCRAFT AND OIL FUEL

THE vast and growing use of oil and the consequent demand for it vitally affect our commercial stability in peace and our safety in war. Moreover, the non-essential use of oil has produced the great coal problem.

The more petrol we use the more crude oil must we buy and import from abroad; the greater the use of petrol and heavy oil as a source of power, the more are we relying on a foreign product largely controlled both as to price and quantity by foreigners. From Board of Trade Returns it is calculated that in 1925 no less than 13½ million tons of fuel oil were imported into this country. Oil is becoming the firebrand of the world: the struggle for the control of oil wells is increasingly a source of danger and of international jealousy and mistrust.

Though oil for various purposes is required in large quantities, oil burnt as fuel is *essential* for one purpose only—the internal combustion engine. The internal combustion engine is *essential* for two purposes only—motor vehicles and all aircraft. Regarding motor vehicles it is clear that oil fuel, as petrol, must be obtained in quantity for peaceful purposes. The quantity of oil fuel required for aircraft must be very large. In the new three-engined passenger planes provision has to be made for carrying 300 gallons (nearly a ton) of suitable fuel.[1] The daily requirements of the Royal Air Force in peace must be correspondingly great. Aircraft engines not only devour oil fuel in quantity, but require a quality exceeding in refinement the petrol used for other purposes and at a correspondingly enhanced cost—1s. 7d. per gallon in bulk.[2] The present performance of aircraft

[1] *Flight*, 10. 6. 1926.

[2] At the Air Force Pageant at Hendon, 3rd July, 1926, 13,500 gallons of spirit were used (*Parl. Debs.*, 9. 7. 1926)—approximately 45 tons—at a value of not less than £1,210.

depends directly upon this highly refined product with an admixture of benzole. It is impossible to run high-compression engines such as our present aero engines on straight petrol, for petrol in such engines, without benzole, detonates instead of burns.

Mr. H. E. Wimperis, Director of Scientific Research to the Air Ministry, says: "Detonation has been prevented by adding 20 per cent. of benzole to ordinary Aviation Spirit, but this practice was not satisfactory because the freezing-point of the mixture was not sufficiently low, and for other reasons."[1] If the engines were modified, a thing which could not be done in a moment, the performance of the aircraft in which they were installed would fall off very considerably.[2]

In war, petrol can be strictly rationed and the requirements very substantially reduced as far as civilian use is concerned, but if as we are assured the battle is to be waged in, and the Empire defended from the air, tens of thousands of aeroplanes must be employed.[3] For these the provision of fuel must not only be on a gigantic scale, but the supply must be assured. Admiral Sir Edmond Slade says[4] that when it comes to war we may require 30, 40, or even 50 million tons of fuel every year. For this we must depend upon the goodwill of foreign countries.[5] The oil would have to be brought from America across the Atlantic and from Persia along the Mediterranean. If America were not friendly, one source would be cut off; the supply from Persia might be inter-

[1] *Engineering*, 18. 6. 1926.

[2] The *Morning Post*, 16. 6. 1926. Benzole in war is required for explosives, and it is doubtful if the supply is enough for the two purposes.

[3] "Even at the close of the late War we had begun to experience the difficulties arising from a lack of suitable fuel." (*J. of R.U.S.I.*, p. 135.)

[4] *J. of R.U.S.I.*, February, 1926.

[5] "Only something like 2 per cent. of the world's oil supplies comes out of the British Empire." The United States of America possess 84 per cent. of the world's oil, and 60 per cent. of the crude oil now imported into this country comes from the U.S.A.

fered with, for "control in peace does not connote control in war; control in peace is financial, control in war is physical. We may have financial control of all the things in the world, but when it comes to war we may find that we have not got control of any." In any case, the vessels carrying such oil as could be obtained, coming from definite ports and proceeding along more or less definite sea routes, would form most desirable and attractive targets, since "the Royal Air Force would be completely paralysed without a constant supply of petroleum of great purity and of a particular specification." The protection of these oil-carrying vessels—a vital matter to the Air Force—would be the affair of the Navy. As long as she was in command of the sea she could ensure the safe delivery of the crude oil available, and the distribution of the refined product. Therefore, the greater we essay to make our air weapon the more will we be on sufferance to other countries, and the greater the responsibility of our Navy and the *necessity of increasing its strength.*

The extraordinary strategical danger which these facts reveal is sufficient to account for the extreme and thinly veiled anxiety of responsible authorities. Believing that we are witnessing the dawn of the "Air age"; realising that an "Air age" demands a corresponding "Oil age"; appreciating that one of the few natural products denied to the British Empire is oil in its crude state, and that we are under tribute in peace and at the mercy of foreign countries in war, the demand to convert our coal into oil is insistent, with a growing belief on inadequate grounds that research, if generously subsidised, can make the conversion of British coal into oil an economic possibility. The wish has became father to the thought. If the widespread belief in the future of the air continues to hold sway, and the conviction persists that the safety of the country depends upon 'air power,' the outlook is dark indeed, and there is presented the paradox of 'air supremacy' placing Britain and her Empire in

fee to foreign and it may be to unsympathetic if not definitely hostile countries.[1]

Mercifully the belief in the power of the air is ill-founded. Facts have been presented which prove that this power is illusory. The opinions which have been quoted, even when critical of extravagant claims, are those of believers, not disbelievers, in the future of aircraft for peace or war. When physical and economic facts inexorably force the abandonment of the air, the oil problem will be largely diminished.

It is obvious that the use of oil for motor vehicles and aircraft is essential. For ships and trains its use is optional and must eventually be governed not by sentimental reasons or by price alone, but by the balance of advantages, of which one, and that the most important, is absolute security of supply under all conditions. "It is an open secret that during the Great War there were occasions on which the ships of our Fleet, with their boilers burning oil, were in serious straits for the fuel necessary to enable them to put to sea; if all, or even a majority, of our merchant ships had been dependent on oil-engines, the importation of essential supplies of food and material must have been much more gravely jeopardised than it was, because in the absence of oil the vessels on which we relied would have been unable to move."[2]

Proposals to use petroleum were first made by the late Admiral Selwyn about fifty years ago, but his efforts were defeated from various causes. "Twenty years later (about 1895) another pioneer appeared before the shipping world, Mr. Marcus Samuel, who had secured a concession in Borneo of oil-bearing land, and who was resolved to find a market for the oil and to develop methods of consuming it in the economical production of power."[3]

[1] "Your air security depends on getting your power from overseas!" (Mr. Hardie in the Debate on the Air Estimates, *Parl. Debs.*, 8. 3. 1926.)

[2] *The Times*, 29. 4. 1926.

[3] Lecture to the Royal Society of Arts, February, 1925. At this meeting Lord Bearsted himself was in the chair.

It is due to the late Lord Fisher that oil replaced coal in the Navy.[1] Writing to Sir Marcus Samuel,[2] 22nd November, 1911, Lord Fisher said: "What I am driving at is oil alone for fuel and the introduction of warships with the internal combustion propulsion."

In the Royal Navy there is "an almost complete transition from the use of coal to that of oil fuel in its most important units,"[3] and the Mercantile Marine is following the example of the Fleet in discarding the use of British coal.

Though the sea power of Britain in all its manifestations is vital to our existence, we accept, as long as we rely upon oil, "that our sea power is *on sufferance*, and that it is largely on sufferance by the United States of America because most of our oil comes from there; it is quite hopeless for us to accede to any proposal to use the British Fleet for any form of sanctions unless the U.S.A. backs up those sanctions."[4]

It appears that the relative value of coal and oil burnt under furnaces to produce steam, taking both price and efficiency into consideration, is considerably in favour of coal even at its present high price; but this advantage is affected by the greater labour[5] required for the use of coal—against which must be set the special and great provision of oil tanks and plant, the risk of fire, and the cost of defending these vital supplies in case of war against destruction by naval or aerial bom-

[1] *Journal of the Royal Society of Arts*, 27.2.25, pp. 338-9.

[2] Knighted in 1898, Baronet 1903, Baron Bearsted of Maidstone 1921, Viscount 1925.

[3] Moreover the Army, with its tanks—small and large—and general 'mechanicalisation,' is becoming more and more dependent upon petroleum—even its horses are now sometimes carried from point to point in motor lorries.

[4] General Sir George Aston, *J. of the R.U.S.I.*, February, 1926, p. 138.

[5] With the large number of unemployed men the supply of labour would present no difficulty.

bardment or capture by the enemy. Moreover, vessels to burn oil cost more to construct than vessels designed to burn coal, and in war coal provides a valuable form of defence against shell-fire.

The Diesel engine—an internal combustion engine—burning oil inside its cylinders, has come to be regarded as a formidable rival to the engine which burns fuel under its boilers to make steam. But though this engine carries with it certain definite and grave disadvantages, its protagonists have expressed the expectation that in the near future they will witness the entire disappearance of steam-propelled vessels from the seas and the displacement of no less than 300,000,000 tons of coal by oil.[1]

On the whole cost and efficiency aspect there may be that nice balance which is calculated to give rise to controversy and difference of opinion. On the broad economic side there is no room for controversy. It would clearly be to the great advantage of the country if the Navy and the Mercantile Marine reverted to the use of coal. It could hardly be expected that such a course would be pursued on purely patriotic grounds, but a policy which directly benefited the economic condition of the country would undoubtedly be to the advantage of the Royal Navy and the British Merchant Service.

"Because it was realised that the development of oil-fired engines menaced England's coal wealth, leading technical minds applied themselves to winning anew for the British mining industry the value which had been so substantially written down by the appearance and perfection of the oil-engine," and "British engineers have succeeded in producing a steam-engine which can be fired with British coal and which will give a performance approximating the efficiency of the Diesel engine. Not only does this promise a bigger demand for British coal than in recent years, but it anticipates a

[1] *Journal of the Royal Society of Arts*, 27. 2. 1925, pp. 359-360.

reduction in the running costs of the British Mercantile Marine."[1] The new vessel, the *King George V.*, designed by Sir Charles Parsons, "represents the latest challenge of steam to the oil engine as an instrument for the propulsion of ships." "Anything that will foster the use of coal as such and lessen our dependence on oil imported from oversea is to be welcomed in the national interest."[2]

But whether this new high-pressure turbine proves successful or not,[3] it should not be regarded as the saviour of coal. The turbine has many disadvantages compared with the best modern reciprocating engine—even small defects in turbines may entail the dismantling of a ship for repairs, with the result that the vessel is laid up for many months. The reciprocating engine, in the opinion of disinterested authorities, deserves the pre-eminent position on account of its cheapness, its efficiency, its simplicity, its reliability, and its ease of maintenance and repair. For the propulsion of ships other than high-speed men-of-war,[4] reciprocating engines have many outstanding advantages; for merchant vessels of all types, and for men-of-war where high speed is not required, it may be regarded on balance as the ideal means of propulsion.

Patriotism, commonsense, and self-interest conspire

[1] The *Morning Post*, 7. 6. 1926.

[2] *The Times*, 29. 4. 1926. It is relevant to refer to the growing unpopularity and disgust at the pollution of our territorial waters and harbours—with the consequent destruction of fish and bird life and the defilement of our sea beaches. A Conference on oil pollution in navigable waters has lately been sitting at Washington. It was stated that "no fewer than 500,000 barrels of oil are annually discharged at sea." "It was decided to recommend the establishment of a system of prohibited areas."

[3] Great pressures and the very high temperatures which develop in superheating introduce metallurgical problems of a serious nature.

[4] These ships have insufficient height between decks to admit of the use of a slow-running engine of long throw giving high speed to the ship.

to show that we should discard the unnecessary use of oil and utilise to the utmost the source of power we possess in such full measure—*the best coal in the world*. It would seem that from the strategical and broad economic point of view, and from the narrowness of margin that separates the advantages of coal and oil, a tax upon all imported oil as opposed to subsidies to the coal industry might with great advantage be imposed. Such a method of reviving our vital home industry, a main source of our economic wealth, would be unlikely to arouse the opposition of the strictest Free Trader, since the tax would be levied on *all* imported oil. It should certainly commend itself to those whose economic creed includes Protection, Safeguarding, and Subsidies.

A fine discrimination in the use of our various appliances and resources is one of the most pressing and outstanding needs of the present time. Such a discrimination would not necessarily accept new means because they are new, neither would it be deterred from retaining old, proved, and economic methods because they are considered old. New methods are not necessarily progressive even though described as 'scientific.' The need of discrimination is particularly necessary in dealing with the methods of transport[1] by road, rail, or sea. Discrimination at once dissolves such catch-words as "Oil age," "Air age," or "Wireless age." We can still, if we will, be masters of our material and arbiters of our fate.

[1] Our forefathers, urged by necessity and obedient to first principles, had the wisdom to perceive that heavy loads should be carried on steel rails. They therefore laid at enormous cost the world-renowned *permanent ways* of this country. Untaxed oil has transferred a large portion of heavy traffic from unsubsidised steel rails and steam traction to our subsidised highways. These old highways now cost £60,000,000 yearly for maintenance and repair—£40,000,000 of this vast sum is drawn from the pockets of the general public as ratepayers. Not only the highways but the byways are losing their ancient charm, and are being rendered unsafe and unpleasant for pedestrians. Moreover they are becoming unfit for horse traction, still for many purposes the most economical and suitable form of transport.

With coal for our Navy[1] and our Mercantile Marine, and with the abandonment of 'air supremacy,' vital dependence upon foreign countries will cease, and the insistence upon a heavily subsidised research for the conversion of good coal into oil will vanish; what can economically be extracted from inferior and cheap grades of coal will surely excite the interest of men of acumen, qualified by attainments and natural capacity to deal with the problem without heavily subsidised research. Action or policy in the realm of material things based on vague theories or false premises must inevitably lead to quackery, and quackery on a great scale must lead to economic ruin. The touchstone of the soundness of any undertaking is its ability to succeed without Government encouragement, spoon-feeding, or State doles.

[1] Except where oil is specifically indicated.

APPENDIX I

EMPLOYMENT OF OUR AIRSHIPS DURING THE WAR

At the beginning of the War we had seven small airships —by 1918 a total of 103 had apparently been constructed.

The ring of airship stations ultimately erected round the coast of Great Britain during the War must have entailed a large ground personnel, for as many as 200 men were sometimes necessary to land one of these small non-rigid Coastals.

> "When an airship left the shelter of its shed for the landing-ground, the ritual of farewell was usually a comparatively calm and stately process. But the return was not always so easy, and to it the landing party used to look for their excitement. The wind may have sprung up in the interval of the airship's absence; then their efforts to secure the trail rope on its arrival would often give the impression of a 'rugger' scrum. Indeed, it had been necessary on more than one occasion for as many as 200 men to 'walk' a 200-foot Coastal home. Great care has to be exercised and much energy expended during such an undertaking to ensure that an airship's nose is kept 'head to wind' until the moment arrives for a rapid wheel into the entrance of the shed. A false order or faulty execution and the damage might be fatal to the ship."[1]

So far as details can be extracted from the very limited sources of information available, it would seem that of this total of 103 airships, 53 were lost with their crews numbering 239 men, but whether by accident or by enemy action has not been published and is not generally known.

These small non-rigid coastal airships, mainly 'Blimps' with crews of three to five men, were used for

[1] *J. of the R.U.S.I.*, August, 1925.

local reconnaissance, a restricted and therefore a feasible activity; but though it is estimated that 2,245,810 miles were flown in all, little is recorded of any definite or adequate return for this great effort and their real value has not been established. It is stated that "the weather provided the principal diversion" to these little 'Blimps.'

It is not infrequently suggested that these coastal airships, together with aeroplanes, played in the late War a prominent part in the protection of troop and merchant ships in the English Channel and round our coasts. What little was definitely achieved by aircraft against submarines can only have been accomplished by enormous effort, at correspondingly great cost and of necessity near the shore: even so, as Commander Bellairs pointed out during the Debate on the Air Estimates:[1]

> "The aircraft did less in sinking submarines than almost any other weapon. The statistics of the Admiralty prove it."

The War proved that *Convoy* provided a sure defence against submarine aggression. When escorting craft were not available, *Group Sailing* was effective since latterly all our merchant vessels carried guns for their own protection. To argue that a Convoy arrived safely without casualty owing to the presence of aircraft in the neighbourhood, premises that in their absence the *tactical defence of Convoy* would have failed. A study of Mr. Fayle's "Sea Borne Trade in the Great War" and Captain Frothingham's "Naval History of the World War" clearly shows that there is no ground for this assumption. As a result of Convoy, Group Sailing, and the defensive arming of Merchantmen, the submarine was denied the use of the gun and forced to

[1] *Parl. Debs.*, 8. 3. 1926. "I have heard of lots of things winning the war, but I have never heard that the blimps claimed to win the war." (Captain Rath, U.S.A., Air Service. "Hearings," p. 1106.)

dependence upon the torpedo—a most uncertain weapon[1] in itself, even in favourable circumstances, and available only in strictly limited numbers, for few can be carried in a submarine. Furthermore, in the open sea a great Convoy ran little more risk than single vessels of being sighted.

Committed to under-water attack, a submarine's prospect of reaching a torpedo-firing position becomes remote. She has to submerge many miles from her prey to avoid being sighted, and when once submerged, she has relatively poor mobility. If sighted on the surface before diving, her attack can easily be rendered abortive by alterations of course.

The inability of submarines, *after Convoy and Group Sailing were instituted*, to locate and successfully attack merchant vessels in the open sea, forced enemy submarines to operate at points of convergence near our coasts where *surface craft*, not aircraft, levied a heavy toll.

[1] *Vide* p. 163, note 3.

APPENDIX II

AIRSHIP FLIGHTS OVER THE ATLANTIC

R.34 AND Z.R.3

IT has been said and frequently repeated that the voyage of the R.34[1] and that of the Z.R.3 have gone far to prove that the airship is reliable as a means of transport and suitable for long-distance travel.

The voyage of the R.34 unquestionably ranks as a feat of the highest order, calling for the greatest admiration for the bravery, skill, and resource of the officers and crew. As pointed out by the late Air Commodore Maitland, it was due to good luck that she reached her destination safely and under her own power.

It was at first intended that the R.34 should fly to Newfoundland and back without a stop, but this plan was abandoned. It was then arranged to make a landing at Long Island, U.S.A., for refuelling, regassing, replenishing supplies, and tuning-up engines; it was hoped she would arrive after sixty or more hours' flight on Independence Day.

The distance from East Fortune to Long Island is approximately 3,000 sea miles (3,450 land miles); the R.34 had five engines, each developing 270 h.p. The entire disposable lift of the ship was utilised for carrying her crew, a few official passengers, the necessary food, bedding, etc., a bag of official mail, and as much fuel as she could lift. This was approximately 5,000 gallons of petrol, "the exact amount, of course, depending upon the state of the atmosphere, barometer and temperature, and the purity of the gas in the ship at

[1] All the quotations in this book referring to the voyage have been taken from "The Log of H.M.A. R.34," by Air Commodore E. M. Maitland, unless otherwise stated. Accounts of the flight (communicated by General Maitland) were given in *The Times* of 7th and 14th July, 1919. These accounts are printed as an Appendix to "Commercial Airships," and are inaccurately described as the Log.

the moment of starting."[1] As a matter of fact she got away with 4,900 gallons of petrol.

For this voyage of R.34 to America all ships in the Atlantic were warned to look out, and two battle cruisers, *Tiger* and *Renown*, were detailed to help the R.34 with weather reports and render any assistance.

Before starting (1.42 a.m., 2nd July, 1919) the weather report stated that *unusual quiet* existed over the whole of the North Atlantic Ocean,[2] and the general weather encountered over the Atlantic on the outward journey was not adverse, being mainly fog; thus she reached Newfoundland in good time. Thence her efforts to circumnavigate the area of a thunderstorm off Nova Scotia, and the unfavourable currents encountered in that region necessitated such deviation of course and consumption of fuel that she took in all 108 hours (4½ days) to reach New York, where she arrived on Sunday, 6th July, with all but a few gallons of her fuel spent.

On her return journey (9th-13th July) she had mainly favouring winds—currents carrying her to her home port—which she made after a flight of 75 hours (3 days 3 hours), with 1,000 gallons of petrol to spare.

It is interesting and significant that the R.34 did not sight a single ship in open sea during the voyage to America, and only one on the homeward trip.

The visit of the R.34 stimulated American plans for the building of large dirigibles and the necessary hangars. The construction or purchase of two large airships was authorised by Congress within a fortnight of the landing of the R.34.[3]

The only other ship that has crossed the Atlantic is the Z.R.3 (now the *Los Angeles*).

The Z.R.3, built by the Zeppelin Company for the

[1] *The Times*, 1. 7. 1919. [2] "Log of H.M.A. R.34," p. 4.
[3] *The Times*, 16. 7. 1919.

U.S.A., made her maiden flight at Friedrichshafen (Lake Constance) on 27th August, 1924. She has a capacity of nearly $2\frac{1}{2}$ million cubic feet, which gives a gross lift of 75 tons when filled with hydrogen gas.

"Many improvements, the result of careful research, were incorporated in her design." She has the most approved streamline shape, and is equipped with a new type of engine said to be capable of a speed of 80 m.p.h.

On Sunday, 12th October, 1924, at 6.32 a.m., the Z.R.3 left Friedrichshafen for Lakehurst, U.S.A.,[1] with Dr. Eckener, her designer, on board.

It had been arranged that the Z.R.3 should leave on Saturday morning (11th October), but the weather reports were not satisfactory, and when the crew went on board at 7 a.m. it was found that the heavily laden airship was unable, owing to the fall in temperature, to ascend through the dense mist and cloud that hung over the lake. Two petrol tanks were emptied without producing the necessary effect, and it was decided to postpone the departure for another twenty-four hours.

On Sunday morning (12th October) the crew, having once more taken leave of their friends, went aboard; they were followed by the officers and Dr. Eckener. The last weather reports proved favourable and shortly after half-past six the airship rose with 29 tons of petrol on board[2] steering westward towards the coast of France and Spain.

At 8.30 p.m. the Wireless Station at Nordreich reported that owing to atmospherics no communication with the Zeppelin had been established for the last three hours. At 9.15 p.m. the report came, "Zeppelin passing down Spanish coast," and all was well.

The U.S. cruiser *Detroit*, the *Milwaukie* and the *Patoka* made hourly observations of the weather con-

[1] *The Times*, 13. 10. 1924.
[2] "Hearings," p. 1029.

ditions in the Atlantic. These were sent to the Z.R.3 by the shore stations.

13*th October.*—Z.R.3 passed directly over a British steamer, and was informed by wireless that she was 60 miles out of her course.

11.40 *a.m.*—San Miguel Island in sight . . . " a few hours later the airship rose to 5,000 feet " (to a cooler atmosphere). " Upon returning to her flying height (now about 1,000 feet), a rip 2 feet long was discovered in one of the gas cells. It was immediately repaired, with no worse damage than that a small amount of air found its way into the cell, reducing the purity of the hydrogen. If the hole had been large or not so soon discovered, enough air might have found its way into the cell to make it a dangerous mixture of gas and also to reduce the lifting power."

" On the night of the 13th there were strong adverse winds. When the weather reports came in the morning, it was decided to head to the N.W. It was found then from a ship on the horizon that the Z.R.3 was 120 miles north of her assumed position."

14*th October.*—" The steamer *Robert Dollar*, which hoisted the British Ensign, passed at 9.30.[1]

" Later, the Z.R.3 began to climb, rising to 8,000 feet, letting out about 5 per cent. of her hydrogen, leaving her cells 80 per cent. full. Welcome relief from an oppressively hot temperature came from this temporary ascent above the clouds. In the afternoon fog was encountered. For several hours the airship flew close to the surface of the sea to gauge force and direction of the wind from the waves,

[1] It will be noted that the Z.R.3 sighted several ships on her voyage to America, whereas the R.34 sighted in the open sea on her outward and homeward voyages one only. The great variation in the power to sight objects on the sea from the air is a marked phenomenon of aerial observation. *Vide* p. 104, para. 1.

and then, as the coast was neared, rose above a 600-feet high fog bank which extended for 40 miles."

New York, 13th October.—"It is expected Z.R.3 will arrive at the Naval Station, Lakehurst, New Jersey, on Wednesday morning.

"Every precaution will be taken when the Z.R.3 reaches Lakehurst to prevent her suffering accidental damage. The naval officers there are concerned to get the hydrogen out of her gas-bag without delay, in order to substitute the non-explosive helium gas."

New York, 15th October (Wednesday).—"Z.R.3 successfully landed at Lakehurst this morning at 9.55 o'clock (U.S. time), after a journey of over eighty hours—with twenty hours' petrol left."

The Z.R.3 had 6 tons of petrol left in her tanks on her arrival, and had therefore used 23 tons of fuel on the voyage. Her gross lift was 75 tons with hydrogen gas; she carried on this trip 29 tons in fuel—more than one-third of her total lift.

APPENDIX III

AIRSHIP R.38

From the Report of the Accidents Investigation Sub-Committee
(*R. and M.* 775)

THE R.38 (2,700,000 cubic feet capacity) was commenced by the Admiralty in August, 1918, and was originally intended for war service in the North Sea. All airship work was transferred from the Admiralty to the Air Ministry in October, 1919, and the Air Ministry took over the works in April, 1920. In the construction of the R.38 a great advance was sought and certain new features were introduced.

Weekly conferences of the design staff of the Royal Airship Works were held during the construction of the ship.

At the request of the Airship Design Department of the Admiralty, an investigation had been undertaken by the National Physical Laboratory in order to obtain information regarding the aerodynamic characteristics of R.38. A report dated May, 1920, was issued which indicated that the resistance of R.38 compared unfavourably with that of R.33; the fins also appeared to be less efficient than those of R.33. This report stated that, though somewhat unstable, her stability was an improvement upon that of R.33, and moreover, that her controls were much more powerful.

The tests previous to her first flight were not reassuring.

The first flight was on the night of 23rd-24th June, 1921; it lasted seven hours and showed defects in her controls, rudders, and elevators.

The second flight took place on the night of 28th-29th June. Further defects were discovered, and a subsequent inspection revealed constructional weakness in the fins. These defects were remedied as far as possible.

The third flight was taken on the night of 17th-18th July. At a speed of 50 knots it was found that it was difficult to handle the ship, and certain girders amidships failed. She returned to Howden and was subsequently repaired.

The fourth flight was disastrous. The airship left Howden on 23rd August, 1921, and carried out various trials for thirty hours. The weather continued good, and rudder trials were made at a speed of 54 knots. During these trials the structure failed between frames 9 and 10. The ship then broke into two portions. The forward portion caught fire at the fracture and the fire spread rapidly due to the presence of escaping petrol in the keel. An explosion followed which led to the collapse of the structure and the ignition of the liberated hydrogen gas. A second explosion took place when the forward portion reached the water. The death-roll was 44.

The following, among other conclusions, were arrived at by the Committee.

> " The weather at the time did not contribute to the accident."
>
> " The accident was due to structural weakness in the design of the airship."
>
> " Owing to instability of the airship the movements of the controls necessary to keep her on any particular course were large and rapid."
>
> " Having regard to her size and speed, R.38 was considerably weaker than previous British rigid airships."
>
> " During design no calculations were made of the stresses due to the aerodynamic forces to which the ship would be subjected."

Representatives of the National Physical Laboratory were aboard on the four flights of the R.38, and two lost their lives when the airship collapsed.

APPENDIX IV

THE AIRSHIP POSITION IN OTHER COUNTRIES

THE U.S.A. has now one rigid airship only—the *Los Angeles* (Z.R.3), for the R.38 (Z.R.2) broke asunder over Hull in 1921 before delivery, the *Roma* was completely wrecked in 1922, and disaster overtook the *Shenandoah* (Z.R.1) on the 3rd September, 1925. The *Los Angeles*—a vessel constructed for commercial purposes—alone remains.

It is understood that the U.S.A. had planned to build another airship (G.Z.1), with a capacity of 10,000,000 cubic feet (twice the capacity of the R.100 or the R.101), probably as a result of the ambitious airship programme of this country, but since the disaster to the *Shenandoah* the plans for the construction of this giant Zeppelin are to be delayed; meantime a small all-metal dirigible is to be built and put to thorough test.

The *Shenandoah* (682 feet long and 2,148,070 cubic feet capacity) was built at Lakehurst, U.S.A. Her design was derived in the main from the German airship L.49; important modifications were in accordance with the German airship L.72, and were towards an increase of strength. She is said to have been the strongest airship that has ever been constructed. She was fitted with water-recovery apparatus. On the 4th September, 1923, the *Shenandoah* made her first flight—her inflation with helium required the whole output of Fort Worth from April to September, and involved a sum of £50,000, excluding transportation and labour at Lakehurst.[1] In January, 1924, she broke away from her mooring mast and sustained extensive damage. The airship accomplished a test flight over the Rockies in October, 1924; at one moment she narrowly escaped a high peak, missing it by a few feet only. On the outward journey she sustained some damage while being moored—this

[1] *Engineering*, 19. 2. 1926, p. 221.

damage was repaired in 120 hours, and she resumed her flight. On crossing the Rockies on her return journey the *Shenandoah* was obliged to throw overboard all her water ballast and nearly 200 gallons of petrol in order to rise to a safe height. On her arrival at Lakehurst difficulty was experienced in landing.

A particularly powerful wireless apparatus,[1] weighing some 15 cwts., was installed in the *Shenandoah*, necessitating the removal of one of her six engines (300 h.p. each). The U.S.S. *Patoka* was reconditioned as a mobile base for this airship.

The *Los Angeles* (Z.R.3), the latest airship completed, 2,400,000 cubic feet capacity, arrived in New Jersey from Germany in October, 1924. She made her maiden trip in America from Lakehurst to Bermuda in February, 1925; there were no facilities for landing. She was moored to the *Patoka* successfully, and men were left on watch ready to release the ship in case of necessity. The disposable lift of the airship being small, all utensils are of aluminium, and the supply of water for washing purposes is strictly limited. Smoking is not allowed. The *Los Angeles* has not been navigated at much over 4,000 feet in order to avoid valving helium, for height would be gained at too great a cost. There was a proposal to try the *Los Angeles* on a passenger and freight service between Chicago and St. Louis; under the Peace Treaty she cannot be used for war purposes.

On 7th June, 1925, the *Los Angeles* started a flight to Minneapolis to join in the Norse celebrations, but had to turn back owing to engine trouble. The trip was abandoned half-way, she was in the air for twelve hours only, and made twenty-five attempts before being able to moor. On 9th June the airship *Shenandoah*, which was then deflated, was ordered to make the trip previously scheduled for the *Los Angeles* as soon as the *Shenandoah* could be made ready and helium transferred. On 15th June the Commanding Officer of the *Shenandoah*

[1] *The Times*, 11. 8. 1925.

recommended that the flight be postponed until September on account of the probability of unfavourable weather conditions in the mid-West during July and August. Prior to the receipt of this letter the Chief of Naval Operations had issued orders (dated 19th June) that the *Shenandoah* should leave as soon as she was ready. *In consequence of the Commanding Officer's anxiety about the weather conditions in July and August a consultation was ordered;* it was held at Washington on 30th June, and the orders of 19th June were revoked.[1]

A mooring mast for rigid airships had however been erected at Detroit, Mich., by Mr. Henry Ford—the first to be erected by private enterprise. It was completed about 9th July, and the Navy Department had been requested to send a rigid airship to test the mast.[2] On 20th July the Commanding Officer of the *Shenandoah* was asked to submit an itinerary for a mid-West flight in the early part of September, and to test the mooring mast at Detroit. Though Commander Lansdowne recommended two separate flights—one during the last week of August to test the mast and a second on 7th September to the mid-West—he was directed on 12th August to do both in one flight, beginning on 2nd September. At the same time he was fully consulted, especially on the ground of possible adverse weather conditions; in fact the orders issued to him included the clause:

> "Should the dictates of safety and the weather conditions existing make it advisable, the Com-

[1] *Vide* p. 43, para. 2.

[2] "Since the *Shenandoah* disaster there has been a reluctance," it is asserted, "on the part of the departmental officials to authorise any unusual flights that do not come under a strict classification of military manœuvres. This reluctance is due partially to a desire to avoid criticism from the standpoint of failure to economise, and also *to avoid taking any risk of any further disaster.*" "It is pointed out that considerable opposition has developed to the plan for sending the *Los Angeles* to Detroit to test out the mooring mast there." (*Army and Navy Journal* (U.S.A.), 28. 8. 1926.)

manding Officer of the *Shenandoah* is authorised to make such modifications in the above itinerary as he deems necessary. . . ."

Before leaving Lakehurst at 2.52 p.m. on 2nd September, the Commanding Officer obtained and considered the latest weather maps and reports.[1] The 8 p.m. weather reports were received, mapped and studied. The scheduled weather reports from Lakehurst for the region being traversed were received about midnight and discussed. They indicated nothing which rendered it unsafe or inadvisable to proceed. Between 3 and 3.30 the Commanding Officer, the Executive Officer, and the Aerological Officer, all of whom were in the control car, observed and discussed the first apparently unfavourable weather conditions, and they continued for two hours in continual observation and discussion, but none of the usual cloud formations indicating abnormal air currents were observed.

About 5.22 a.m. the airship was at a height of 1,800 feet, but was making little or no ground speed, due to strong adverse winds. Then she "began to rise under the influence of vertical air currents: rose to a height of 3,150 feet in eight minutes (170 feet per minute), was brought under control and steadied at that level for six minutes; then rose again and more rapidly to 6,100 feet in ten minutes (300 feet per minute); dropped rapidly to 3,000 feet in three minutes (1,000 feet per minute); and finally rose again, sharply up by the nose, to probably 3,700 feet at which point the ship broke. This last rise was accompanied by a movement of rotation of the whole ship in a horizontal plane and by violent rolling and pitching. During all these movements the ship was out of control."[2]

[1] In accordance with the established policy of the department, Lieutenant-Commander Lansdowne "was authorised to defer the trip, change the itinerary or abandon it altogether if in his judgment such changes were rendered necessary by the weather conditions." (*Army and Navy Journal* (U.S.A.), December, 1925.)

[2] "Technical Aspects of the Loss of the *Shenandoah*," pp. 688-89.

The *Shenandoah* was equipped with only two parachutes, which were carried for the purpose of landing personnel in order to make ground preparations in case it became necessary on any flight to make an emergency landing at a point where preparations had not previously been made. The established practice on both the *Shenandoah* and the *Los Angeles* was to carry only two parachutes. "Although it is possible that some lives might have been saved had parachutes been carried and been actually worn by officers and crew at the time of the break-up of the ship, it is not advisable, for the wearing of the present type of parachutes would add to the general risks and hazards of handling such ships, due to their interference, especially in emergencies, with the quick and efficient performance of duty by the personnel. The lesser danger must be accepted to avoid the greater risk."[1]

France has now one rigid airship only, the *Méditerranée* (formerly the German *Nordstein*), which was fitted with new gas-bags in August, 1923, and commissioned with the *Dixmude* for experimental flying with the Naval Air Force.

The *Dixmude* (formerly the German Zeppelin L.72) made a successful flight in August, 1923, of fifteen hours, and afterwards accomplished two endurance flights of 54 and 118 hours respectively, the latter being a world's record. On 18th December, 1923, she left to carry out an instructional cruise to the Sahara. She did not return, and ten days later the dead body of her Commander was picked up off Sicily. In May, 1924, the High Commission of Inquiry found that "the loss of the airship was due to lightning."

No flights by the *Méditerranée* have been recorded since 1923, and it would appear that the French have abandoned any attempt at airship development, and hesitate to subject their remaining airship to test. The

[1] Findings of the Court of Inquiry, *Army and Navy Journal* (U.S.A.).

Chamber has refused to sanction a sum to cover the cost of establishing an airship route from Marseilles to Algiers.

GERMANY possesses no airships, being restricted under the Peace Treaty. The Zeppelin Company constructed the Z.R.3 (the *Los Angeles*) for the U.S.A. as part of the Reparations, her use to be restricted to commercial purposes only.

To celebrate the twenty-sixth anniversary of the first ascent of a Zeppelin, an appeal was launched on 20th August, 1924, by Dr. Eckener for £200,000 for the building of a new Zeppelin by public subscription. This amount was not obtained, but a large sum was secured before the State prohibited the collection of further money. Meanwhile this large airship is being constructed, and it is reported that she is intended for a service between Berlin and South America. This ship will be of 3,708,000 cubic feet capacity, and therefore greater than the Z.R.3. She will have five engines of 450 h.p., and also two auxiliary engines of the ordinary aero-engine type.[1] "These will be used only in emergencies, as when fighting a strong adverse wind." The speed is given as 83 m.p.h., the paying load 15 tons, and the range 6,200 miles.[2]

SPAIN has two very small semi-rigid airships purchased from Italy. In 1922 a Company known as the Seville-Buenos Aires Airship Company was formed. The necessary capital was subscribed, and the scheme approved by the

[1] Discussing the removal of one of the engines of the U.S. *Shenandoah* at the Court of Inquiry, Professor W. Hoogaard said: "It seems inadvisable to give an airship an extra engine to be used only in case of emergency. To sacrifice a great part of the precious lift for the purpose of carrying what will be ordinarily a dead weight can only be justified if the safety of the ship is thereby materially increased. But, from the point of view of safety, it appears that an increase in radius of action by carrying a greater amount of fuel is of more value, and reserve fuel has the advantage that it may be used in emergency as detachable ballast." ("Technical Aspects of the Loss of the *Shenandoah*," p. 648.)

[2] The *Morning Post*, 16. 4. 1926.

Spanish and Argentine Governments. The airship sheds were to be completed about the end of 1924. Nothing further was noted of this Company until recently, when the fame and popularity of Major Franco stimulated Commander Herrera, who it is stated is preparing for a non-stop flight around the world by airship, starting from and returning to Seville. The airship is to hold forty passengers and crew, and to weigh 140 tons, including stores, provisions, fuel, etc. The world will, it is estimated, be spanned in twenty-two days. Commander Herrera considers the winter the most favourable season to court success. The Council of State has approved the following provisions for an airship service: the Company must build and equip an air port at Seville, and must open a service within three years at its own expense. At first one return voyage must be made each month, and then a fortnightly service. A weekly service will eventually be demanded, as well as a regular service between Spain and the Canary Islands. The South American service airships will be capable of carrying forty passengers and 10 tons of freight, and those on the Canary Islands service sixteen passengers and 1 ton of freight. But the airships cannot be built in Spain and the Company are prepared to hire vessels.

ITALY has one rigid airship, the *Esperia* (formerly the German Zeppelin *Bodensee*), and other small semi-rigids. Signor Nobile has constructed the new 1924 semi-rigid, the N.1 (since famous as the *Norge I.*). The N.1 was presumably built for commercial purposes; with a length of 347 feet, she had a cubic capacity of 672,000 feet, a maximum speed of 62 m.p.h., a useful load of 6 tons, and it is said to have been designed to carry twenty passengers. The N.1 made her maiden flight in April, 1924. It was proposed by the Italian authorities to take the British Air Minister, Sir Samuel Hoare, for a flight on his visit to Italy in the spring of 1925, but the weather conditions were not favourable and the airship trip was abandoned.

Captain Amundsen bought this airship for his Polar Expedition, for which various modifications were carried out in the ship, including "a general lightening to increase its range,"[1] and adaptation for mooring to a mast. The ship was handed over to the Aero Club of Norway on 29th March, 1926, and christened the *Norge I.* After her Polar flight she was dismantled by Signor Nobile, and returned to Italy by sea, having been bought back by the Italian authorities.

NORWAY appears to have no military or naval airships, but the *Norge I.*, under the Norwegian flag, navigated the Polar Seas.[2] At the end of the voyage the ship was disposed of. An account of the exploits of the *Norge* is not without interest to those concerned in the navigation of airships.

THE POLAR FLIGHT OF THE *Norge I.* "ROME TO NOME"

Captain Amundsen was extremely anxious to cross the North Polar regions before the end of April. The most favourable time for the attempt was before the spring fogs set in, and his flight was a race against time. He had arranged for the airship to leave Rome not later than Good Friday, 2nd April, 1926: it was the 10th before she could start on account of the weather. On arrival at Pulham on the next day, after a flight of thirty hours, the airship was housed in the hangar and a week's stay was anticipated, but bad weather was approaching from the west. After only twenty hours the *Norge I.* left Pulham for Oslo, where she was welcomed on the 14th by the Norwegians and moored to a mast specially erected. But the depression was still following

[1] In other words, that more petrol may be carried weight must be taken from the structure of the airship; *vide* p. 10, paras. 1 and 2.

[2] Some significant incidents and experiences of the *Norge* during her flight from Rome to the Pole will be found where relevant in the body of the book.

her, and Signor Nobile (her constructor and commander) was anxious to press on to where a hangar would be available during the expected bad weather; the *Norge I.* remained at the capital twelve hours only. Arriving at Gatchina (15th April), after being lost for several hours, she was housed in the hangar there, and awaited the completion of the shed at Spitzbergen and favourable weather. When all was ready at Spitzbergen snowstorms delayed her departure: at last, on the 5th May, she left Gatchina near Leningrad for Spitzbergen, where she arrived on the morning of 7th May.[1] On the 11th May weather conditions were favourable, and the *Norge I.* set out for the Pole and Nome. The following is from the account published in the *Daily Chronicle*, signed by Roald Amundsen and Lincoln Ellsworth:

> "When the *Norge I.* left Spitzbergen the sun compass was set for the North Pole, and every man on board commenced service. The sun's rays aided by furs kept us warm despite the low temperature. Thus we passed between King's Bay and 88 degrees latitude, 140 miles short of the Pole, at an average of 1,350 feet, then we saw fog and mounted above it. The fog rolled under the ship like a woollen ocean. It was a little disappointing. But a wireless report from Norway gave promise of favourable winds on the flight towards Nome. Rifts in the fog permitted us to know that there was no land under us. It was a totally dead environment of wind and sky, and gave a peculiar feeling of nothingness. To our great delight, when we were not far from the Pole, the sun was victorious. On the morning of Wednesday, 12th May, we had the Pole behind us.

[1] A 10-knot tramp steamer starting on Good Friday from Civita Vecchia could have done the same voyage—Rome to Spitzbergen, a distance of 3,780 sea miles—in less than sixteen days, and have reached Spitzbergen on the 18th April. She could, moreover, have carried the *Norge* to the Polar regions in the same manner and condition as that in which the airship was removed from Teller.

"Observations made during the flight, bearings taken to the wireless stations at King's Bay and Green Harbour, and the sun compass, all together permit us to state that we reached the North Pole at 1.30 a.m., 12th May, Greenwich time. Astronomical observations of longitude corresponded almost exactly with the bearings we took, and the measures taken of our speed were controlled by observations of latitude. After the sun's position had been taken, we could then be sure we were over the end of the world's axle tree. We descended to the low altitude of 300 feet, and under reduced speed the *Norge* made the round of the North Pole. Then we continued our flight. The *Norge* was now flying southward, and before seeing known land again we had to cover about 1,500 miles.

"During the morning of Wednesday some of the crew having worked since we left King's Bay, attempted to get a little sleep, creeping into the reindeer sleeping bags on the narrow gangway in the keel. But sleep was almost impossible owing to the cold and the sound of the engines.

"On reaching latitude 86 degrees—275 miles south from the Pole towards Alaska—we had covered half the distance from King's Bay, and found we had consumed 4½ tons out of our 6½ tons of gasolene.[1] Here we encountered fog, and a period of tense excitement began which lasted until the airship reached Teller in Alaska. Sleep was out of the question, our troubles had begun.

"We entered the fog at an altitude of 1,000 feet. After flying in the fog for a while we began to have trouble with the radio. Press messages could not be transmitted, and Malmgreen could not get weather reports, and the getting of the bearings was also

[1] This predicates for the first half of the voyage a strong adverse current; fortunately for the remainder of the journey the current was favourable.

impossible. Our wireless trouble was partly due to electrical disturbances in the air, and partly to ice crusts forming on the 450-feet-long antennæ hanging under the cabin. Later, the windmill of the wireless generator also became covered with ice. Our staunch wireless organisation was now worthless. Our troubles increased hourly.

" High altitude clouds covered the sky, making astronomical observations impossible; only the magnetic compass kept our direction. At evening we descended to a lower altitude and found snow falling. We went up again, but our ship was now laden with ice. We manœuvred to get above the wet clouds, but that meant losing too much gas.

" Ice crust began forming on the ship's engines and propellers, and this was afterwards thrown as projectiles through the canvas of the keel, making holes in it. Our position was critical. But we knew when the ice bombardment started that we were 200 miles from the coast. The possibility faced us of being compelled to march to the coast on the ice if the increasing rents in our canvas forced us to land. There was a possibility of the flying icicles breaking the propellers. But providentially the propellers didn't break. The crew had all their work cut out in making patches. One break was so big that the ship had to be slowed up for repairs. At times we stopped the motors singly to clean off the ice which had collected on them.

" Early in the morning of Thursday (13th May, Greenwich time) several signs indicated we were not far from land. Rime and ice coatings weighed heavily on our airship when first we came above Alaska at Point Barrow. We tried to balance the ship and its weight of ice by shifting fuel to the already emptied tanks. We even sent some men into the rear of the ship[1] in order to counter-weight

[1] *Vide* p. 31, para. 1.

the uneven load. Our airship followed the Alaskan coast and descended to a very low altitude to minimise the dangers. As the fog became thicker and thicker it became more and more difficult to follow the coast contour, and snow obliterated the shore line. At last the fog grew into an impenetrable horizontal wall even at an altitude of 3,000 feet. We continued, however, to ascend. Culmination of the sun made it possible to determine our direction towards the Bering Strait. Efforts to revive wireless communication were in vain. No Alaskan station responded. Interestingly enough we had not blundered in working out our position despite the failure of some of our aids.

"But the wear and tear, the strain of continually sailing in fog, were becoming too much. Our navigator was consequently given orders to bring the ship over land, and as soon as possible, though we could not know how long it would take us to reach land. Sooner than we expected we passed over the coast line, again we saw an Eskimo hut, but we could not stop to ask the name of the place.

"We decided to rise above the clouds in an attempt to obtain a latitude observation, but this was far from easy. Eilsen Larsen was compelled to climb up on the top of the balloon bag with his instruments, as this was found to be the only place he could get the sun's position. Then, as if by a miracle we heard 'Nome' wireless station calling another Alaskan wireless. We were able to head for Cape Prince of Wales. When we rounded this Cape we were sheltered by the Seward Peninsula, but wind gusts tossed the ship about, and the severest ones made her leap several hundred feet in the air. Suddenly on the afternoon of 24th May (European time) we saw a lagoon covered with ice, and the little village of Teller.

"We began to make preparations for landing. First we unshipped a heavy sack containing 800 lbs.

of weights and held to the ship by a strong steel rope. Then a necessary miracle occurred. The wind slackened for a few minutes, making it possible to lower the sack after we had descended to 300 feet. Most unluckily the wind picked up the ship again and drove her towards the houses in the village. We were releasing gas frantically: the ice was so smooth that the anchors found nothing to grip. But good luck was here with us also. Our landing rope was dropped, and down, down we came till we were near enough to the ground for several of the crew to jump off. With the aid of the excited Tellerians they halted the craft only a few yards from some dwellings. We had landed, and without any great damage to our airship or our instruments or anything. Our flight had lasted seventy-one hours. We landed a few minutes before 8 a.m., 14th May, Greenwich time."

Speaking of his experiences Captain Amundsen said: "Our crew, during the last stages of the journey, had suffered cruelly from cold. Our beverages froze, and our sandwiches were turned into solid chunks. To prepare a warm drink was out of the question, since to strike any sort of light is dangerous when the balloon is hydrogen filled. Our first warm meal was prepared by Teller's kind inhabitants. Before we could turn in for sleep we had to remember our instruments. They were all unshipped and safely stored, and then at last—to bed, for a sleep which we almost wished to be without end."

The *Norge* was deflated immediately on landing, and subsequently dismantled for shipment to the U.S.A. Captain Amundsen, Mr. Lincoln Ellsworth, with two others, completed their journey to Nome by dog-sleigh and launch.

The Rt. Hon. L. C. M. S. Amery, Secretary of State for the Colonies, who claims to have always been "a convinced believer in the immense possibilities of the airship," anticipates a quite normal airship route from England to the North-West of Canada over the Polar Seas, following the wonderful expedition of Amundsen.

APPENDIX V

LAST CRUISE OF THE U.S. AIRSHIP *SHENANDOAH*[1]

BY LIEUT.-COMMANDER C. E. ROSENDAHL, U.S.N.

"ON the afternoon of 2nd September, 1925, the U.S.S. *Shenandoah* cast off from her Lakehurst mooring mast and headed west across Pennsylvania.

"By midnight, after a very smooth passage, we had crossed the Alleghenies at an altitude of 3,800 feet. Having been relieved of the navigator's duties by Lieutenant-Commander Hancock, with whom I alternated, I eagerly sought my bunk in the keep and slept soundly after my four-hour watch. At 3.30 a.m. I was called for my next watch, and going to the control car I found, as was customary, that all the lights except those necessary at the instruments and chart-board were purposely extinguished, and that the captain and several other officers were watching the weather from the car windows.

"Captain Lansdowne was a thorough student of flying weather and, although we had safely passed all evident danger from the weather, he remained in the control car watching astern and studying the storm conditions behind us. Suddenly the dull light of the setting moon ahead revealed to the northward on our starboard bow, a thin, dark, streaky cloud forming not far distant, building up very rapidly and apparently moving towards us. The Captain ordered the course changed to head away from this cloud, and almost simultaneously with his order the ship began to rise, the elevator-man detecting the rise instantly by his instruments. We realised then that without the warning of the usually well-defined indications we had run into a 'line squall,' which is made up of rapid upward and downward air currents caused by the intermingling of warm air and colder

[1] Broadcast on Navy Day from Washington—reprinted by permission from *Army and Navy Journal* (U.S.A).

incoming air. Immediately the engines were speeded up and the ship headed downward, trusting that we could successfully fight the ascending current that was carrying us bodily aloft.

"But our hopes did not materialise. The strength of the upward current was greater than the ship's power could combat, and the *Shenandoah* continued to rise. From 2,100 feet we rose to about 4,000 feet, and there the ascent seemed to check, but only momentarily. Again the upward rush took charge, now at a rate greater than we had ever before experienced. All during this rise into the higher rate atmosphere, the buoyant helium within the gas cells was expanding under the reduced pressure. At a certain altitude the cells would be completely full, and any further rise would put them and the ship's structure under pressure which, if unrelieved, might eventually crush the structure or burst the cells and precipitate the ship to the ground. To prevent any excess pressure and to assist the automatic safety valves in their release of helium, Captain Lansdowne ordered the hand valves used also. For full five minutes two of us held these valves open releasing helium, yet in spite of the reduced buoyancy and the downward thrust of the engines, the ship continued its rapid rise. 'She's rising 2 metres per second and I can't check her, sir,' was the report of the elevator-man. The Captain ordered ballast dropped and several thousand pounds of water poured from the ship.

"At 6,200 feet, our rise came to a halt, and we began falling, carried downward by a terrific descending air current. For probably two minutes we descended at a rate of over 1,400 feet per minute, and I for one thought my eardrums would burst. Our only ballast for checking such a terrific descent without crashing was large filled gasolene tanks that were arranged for slipping in just such emergencies.

"Suddenly and abruptly our descent was checked by being caught in another upward air current. Realising

that now our salvation would depend entirely upon the dropping of gasolene tanks when we should again begin to fall, as was inevitable, the Captain ordered me to go up to the keel to make absolutely certain that previous messages had got through, and that they were actually prepared to slip fuel tanks upon receiving the order. Though we still had engine power and full use of the rudders and elevators, the ship was now rolling and tossing about wildly.

" Just as I stepped upon the ladder leading up into the keep, the nose of the ship, as if beginning a loop, shot suddenly upward at an angle I had never before experienced in an airship. The control car seemed not to follow the nose upward, and I heard its wooden supporting struts snap as if wrenched in two. Knowing there were suspension wires inside the struts and other wires holding the car to the ship, I still had no feeling that the *Shenandoah* was doomed.

" Neither did I even dream that I had just seen many of my shipmates and close friends alive for the last time. However, I very soon came to the grim realisation that disaster had overtaken us, for just when the nose had plunged so violently upward, the tail likewise had been hurled upward, breaking the ship at the top and opening her up at the bottom, at about one-third of her length from the nose. The stresses of the enormous conflicting air currents of the disturbance had proved too much for even the *Shenandoah*, that we had considered the strongest rigid airship ever built.

" As I stepped into the dark keel passageway about the car I became aware of the terrible noise of the ship tearing apart. Although almost impossible to describe, it resembled the clashing of hundreds of panes of glass hurled to the pavement or the clashing of a large pile of small pieces of sheet-metal violently jumped over. I found myself hanging on to a rigid part of the structure and almost dazed by the horrible vision of the after part of the ship plunging away from me into space. I looked

forward, and along the bottom I saw the opening in the cover made by the control car in tearing away from the ship. Shortly, I heard a terrible thud, which I knew was that of the control car striking the ground. My departure from it only seconds before, and the fate of its occupants, was too terrible to ponder. I looked aft again, and in the cold grey breaking dawn, I saw the rest of the ship suddenly arrested in its fall by crashing into the ground.

"My part of the ship, free of the weight of the control car and without any engines, rose almost out of sight of the ground, possibly to 10,000 feet. Twice we were in heavy rain. Believing that I was alone, my first impulse was that I would have a difficult time landing safely, as I could not move about freely, due to the shattered condition of the walkway. I shouted towards both ends, and found to my great relief that I still had six shipmates with me.

"We soon located control wires, and by releasing helium and slashing open cells we were able to descend. All during our flight as a free balloon we were spinning dizzily and rapidly, and described a large circle about the other section lying where it had crashed to the ground. In about an hour we landed safely."

APPENDIX VI

U.S. AIRSHIP *SHENANDOAH*

From "Technical Aspects of the Loss of the U.S.S. Shenandoah"

The following points emerged at the Court of Inquiry:

> "That there was nothing on the weather map of 1st or 2nd September to warrant or even suggest the cancellation or postponement of the *Shenandoah's* mid-West flight."
>
> "That precautions were taken for the reception of all weather information available to an airship in flight."
>
> "The existence of high velocity vertical air currents without accompanying cloud formations or other visible indications is unusual, but is a phenomenon known to meteorologists."
>
> "That the cumulus clouds are the result of these vertical air currents and not the cause, and that, therefore, the rising currents may be well established before clouds develop."
>
> "The *Shenandoah* was caught in a forming atmospheric disturbance unmarked by visual indication until after it had enveloped the ship, and this visible only from the ground."
>
> "The storm which caused the disaster was associated with a cyclonic storm of the quite ordinary summer type, but with an unusual direction of travel."
>
> "The final destruction of the ship was due primarily to large, unbalanced, external, aerodynamic forces arising from high-velocity air currents."

One engine of the *Shenandoah* had been removed to instal new radio apparatus, and the effect of this change

is thus commented upon in the report of the Court of Inquiry:

> "As the added weight of the new radio installation was less than the weight of the sixth (removed) engine with its transmission and propeller, this change enabled the *Shenandoah* to carry an additional amount of fuel, increasing, of course, her radius of action thereby. Further, this change permitted a better distribution of weight with a consequent reduction of the static stresses set up in the structure. Although it is agreed that, in general, high speed may be desirable in an airship attempting to avoid storms, it must be remembered that once within the dangerous limits of the storm area, the higher power required for such higher speed, if used, becomes a source of danger due to the additional aerodynamical stresses which might be imposed upon the structure by the operation of this engine. Although witnesses have alleged before this Court that additional power might have been of value in saving the *Shenandoah*, none of them were able to state a definite increment of speed which they considered would have been beneficial to the *Shenandoah* under the actual storm conditions of the disaster. They further did not know whether such speed increment actually remained unused in the *Shenandoah's* power plant capabilities. It is the opinion of the survivors that the presence and operation of a sixth engine in the *Shenandoah* would not have aided her in any way to escape, once caught in the squall. The argument of greater power in the *Shenandoah*, unsupported by the other actual conditions under which the *Shenandoah* was lost, can be offset by the simple statement, absurd as it may sound, that had the *Shenandoah* had less power, she would not have reached the scene of the disaster-bearing storm at the time she did, and, therefore, it

might have been said just as well that lower power might have been of benefit to the *Shenandoah's* welfare. It is a well-known fact that in airship operation a reduction of airspeed when labouring through turbulent air reduces the aerodynamical stresses on the hull. While, in general, the question of high power in airships is open to debate, it is certain in our minds that the absence of the sixth engine in the *Shenandoah* was not a contributing factor in her disaster. It may be pointed out that the R.38, which was known as the Z.R.2, was undoubtedly broken and lost because of the exceptionally high power employed with her structural strength. It is also a matter of record in the findings of the investigation into the loss of the *Roma* that the substitution of engines of greater power than those originally intended for installation was a contributing factor to the loss of the *Roma*."

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